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SELECTION FROM SCIENTIFIC PROBLEMS SOLVED AT CZECHOSLOVAK RESEARCH INSTITUTIONS

According to a well approved tradition a selection of the projects solved at Czechoslovak scientific research institutions in the field of forestry is submitted to our readers. In order to make them accessible for the public abroad these studies are translated into English and provided with Czech summaries. Naturally, a single issue of a scientific magazine cannot encompass the whole broad scope of problems. Nevertheless, an attempt was made to select such contributions that would afford a picture of the general trend of Czechoslovak science at the forestry faculties and research institutes. Obviously, the selection is not fully representative and this is why we refer the interested circles to other international periodicals as well as nonperiodicals published in our country.

And now to the individual papers. The study of Professor Dr. Ing. J. Pelíšek, DrSc., describes ecological conditions of altitudinal soil zonality related to quality class of Norway spruce stands in the Czechoslovakia. The author points out that the relations of available nutrients in forest soils from lowlands to mountain regions follow certain rules, as e. g. decrease of available CaO, K_2O and P_2O_5, decreasing difference of the content of available nutrients between upper and lower soil layers and dropping intensity of the biological nutrient cycle.

Ing. M. Dejmek, CSc., deals in his study with the development of an automated method of information system analysis. The paper is oriented at working out a complex of technological methods of automated information system design.

Ing. V. Štaud, CSc., Ing. M. Dressler, CSc., and Ing. M. Škapa refer on progressive technologies of final felling in the Czech Socialist Republic and solve the construction of various technological methods in exploitable coniferous stands. Basing on the technology of a special wheeled tractor the authors proceed from final felling to railroad transportation or the consumer's timber yard. With the above technology taken as standard other progressive technologies based on new machinery are compared.

Spruce stand spacing and development is the topic of nearly 90 years' research evaluated by Professor Dr. Ing. M. Vyskot, DrSc. The former Research Institute at Mariabrunn near Vienna developed a method according to which trial plots with three-year old transplants at three different spacings (1 × 1 m, 1,5 × 1,5 m, and 2 × 2 m) were established in 1889 in a rather arid area in the proximity of Brno in a group of Fagetum typicum asperuletosum forest types. Secular comparison related to 1973, i. e. after 87 years, demonstrated that the most suitable spacing was 2 × 2 m, i. e. 2500 vigorous plants per 1 ha; this yielded the best results in practically all indices.

Prof. Ing. M. Stolina, CSc., deals with structural potential and functional effect of the forest from the aspect of its protection. In a functionally intergrated forestry the purpose of protection is to afford spatial and temporal forest stand risk forecast both at present and in the future. The importance of preventive steps is constantly increasing, as the present means of pest control are for some functional types a priori excluded.

The contribution of Professor Dr. Ing. J. H a l a j, DrSc., is concerned with thinning of Norway spruce stands from the point of view of deducing production indices and thinning percentage tables. During 1965—1972 309 special areas were founded in the Czech Socialist Republic on which moderate intensity low thinnings are performed. A mathematical model for the determination of decennial percentage in relation to age and stand density is derived.

In the chapter Topical News a contribution of Professor Ing. V. Z á s m ě t a and Ing. J. Š v a r c : Game Management in ČSSR is found presenting the main inventory data, game populations and future outlook of game care. The game management productivity in Czechoslovakia is constantly increasing in the majority of commercial game, which can be especially well seen in pheasants. A special care is devoted to rare game species.

As can be seen from the survey of the main topics the selected papers comprise a large scope of forestry sciences of all levels, i. e. biological, technical and economic. The published contributions offer a partial picture of the effort of Czechoslovak forestry scientists and of their attempts at further development of socialist forestry.

Corresponding member of the ČSAV
Prof. Dr. Ing. M. V y s k o t, DrSc.

VÝBĚR Z VĚDECKÉ PROBLEMATIKY ŘEŠENÉ V ČESKOSLOVENSKÝCH VÝZKUMNÝCH INSTITUCÍCH

Podle osvědčené tradice předkládáme našim čtenářům výběr z úkolů řešených na čs. vědeckovýzkumných pracovištích, jež se zabývají lesnickou problematikou. Aby byly práce přístupny světové veřejnosti, jsou tlumočeny do angličtiny s českými souhrny. Je přirozené, že v jediném čísle vědeckého časopisu nelze obsáhnout celý lesnický výzkum. Snažili jsme se však vybrat takové příspěvky, které naznačují celkový trend československé vědecké fronty na lesnických fakultách a výzkumných ústavech. Tento výběr není přirozeně zcela reprezentativní a zájemce je třeba odkázat na další publikace, jež jsou vydávány v ČSSR.

Studie prof. Dr. Ing. J. Pelíška, DrSc., popisuje ekologické poměry výškové půdní pásmovitosti ve vztahu k bonitám smrkových porostů v ČSR. Uvádí se v ní, že poměry přístupných živin v lesních půdách od nížin až po horské oblasti vykazují některé zákonitosti, např. klesání přístupného CaO, K_2O a P_2O_5, zmenšování rozdílu v obsahu přístupných živin mezi svrchními a spodními vrstvami půd a snižování intenzity biologického koloběhu živin.

Práce Ing. M. Dejmka, CSc., je věnována tvorbě automatizované metody analýzy informačního systému. Práce směřuje k vytvoření souboru inženýrských metod automatizovaného projektování informačních systémů.

Ing. V. Štaud, CSc., Ing. M. Dressler, CSc., a Ing. M. Škapa se zabývají progresívními technologiemi v mýtních těžbách České socialistické republiky a řeší konstrukce různých technologických postupů v mýtních jehličnatých porostech. Vychází se z technologie speciálního kolového traktoru od mýcení až po transport železnicí nebo sklad spotřebitele. S tímto standardem jsou srovnávány progresívní technologie na bázi nových strojů.

Spon a vývoj smrkového porostu je tématem takřka 90letého výzkumu, který vyhodnocuje prof. Dr. Ing. M. Vyskot, DrSc. Bývalý výzkumný ústav v Mariabrunnu u Vídně vypracoval metodiku, podle níž byly v roce 1889 založeny tříletými školkovanými sazenicemi pokusné plochy se třemi rozdílnými spony (1 X 1 m, 1,5 X 1,5 m a 2 X 2 m) v sušší oblasti blízko Brna ve skupině lesních typů Fagetum typicum asperuletosum. Sekulární komparace vztažená k roku 1973, tj. za 87 let, ukazuje, že nejvhodnější spon je 2 X 2 m, tj. 2500 silných sazenic na 1 ha, který vykazuje prakticky ve všech ukazatelích nejlepší výsledky.

Prof. Ing. M. Stolina, CSc., pojednává o funkčním potenciálu a funkčním efektu lesa v aspektech jeho ochrany. Ve funkčně integrovaném lesním hospodářství je úkolem ochrany poskytovat prostorovou a časovou prognózu ohrožení lesních porostů v současnosti i v budoucnosti. Přitom vzrůstá význam preventivních opatření, poněvadž současné prostředky boje proti škůdcům jsou v některých funkčních typech lesa apriorně vyloučeny.

Prof. Dr. Ing. J. Halaj, DrSc., se zabývá probírkami ve smrkových porostech z hlediska odvození produkčních ukazatelů a tabulek probírkových procent. V letech 1965—1972 bylo na území ČSR založeno 309 účelových ploch, na nichž se realizují podúrovňové probírky mírné intenzity. Odvozuje se matematický model pro určení decenálního procenta v závislosti na věku a zakmenění.

V Aktualitách je zařazen mimo jiné příspěvek prof. Ing. V. Z á s m ě t y a Ing. J. Š v a r c e : Myslivost v Československé socialistické republice, který uvádí hlavní inventarizační údaje, stavy a perspektivy péče o lovnou zvěř. U většiny druhů užitkové zvěře v Československu se myslivecká produkce trvale zvyšuje, což je patrno zejména u bažantů. Zvláštní péče je věnována vzácným druhům zvěře.

Jak je z výčtu hlavních tezí patrno, zahrnují zvolené příspěvky velký areál lesnických věd ve všech sférách, tj. biologické, technické i ekonomické. Opublikované práce jsou tedy dílčím obrazem úsilí československých lesnických vědců a jejich snah o další rozvoj socialistického lesního hospodářství.

Člen korespondent ČSAV
prof. Dr. Ing. M. V y s k o t, DrSc.

J. Pelíšek

ECOLOGICAL CONDITIONS OF VERTICAL SOIL ZONALITY AND QUALITY CLASSES OF SPRUCE STANDS IN THE BOHEMIAN UPLAND REGION (CZECHOSLOVAKIA)

The relief in Czechoslovakia is distinctly dissected within elevations ranging from 100 to 2600 m. This has resulted, among other things, also in a distinct vertical zonality of climate and soils, or of the environment for production, which, in the wider sense of the word, is essential for the planning of agricultural and silvicultural primary production.

Over the range from the lowlands to the high mountains, the following vertical zones of soils on silicate rocks occur in Czechoslovakia:

1. The zone of semigley and gley soils in the river flats with inundated forests.
2. The zone of chernozem soils with phytocoenoses of the oak zone — elevations 200—300 m.
3. The zone of brown forest soils of lowlands with phytocoenoses of the oak zone — elevations 250—350 m.
4. The zone of illimeric podzol soils in lowlands and rolling grounds with phytocoenoses of the beech-oak and oak-beech transition zones — elevations 250—600 m.
5. The zone of ochre forest soils with phytocoenoses of the beech zone — elevations 400—900 m.
6. The zone of rusty forest soils with phytocoenoses of the beech-fir zone — elevations 700—1200 m.
7. The zone of chocolate-brown mountain forest soils with phytocoenoses of the beech-fir-spruce zone — elevations 1200—1500 m.
8. The zone of mountain podzol soils with phytocoenoses of the spruce and dwarf-pine zones — elevations 950—1800 m.
9. Above the timber line are the zones of meadow, brown and grey, subalpine soils, and finally the top zone of detritus and stones.

Individual vertical zones of the soils also feature distinct climatic conditions; these are closely asscciated with vertical differentiation of the climate in Czechoslovakia. The vertical soil zones of the lowest elevations receive the smallest amounts of precipitation annually, 500—700 mm. As the elevation increases, the amount of precipitation increases, too, and the highest elevations have precipitation of as much as 1800 mm annually. Things are similar with the average annual temperatures; in the lowlands they are 8—10 °C to drop, at elevations of the top mountain zones, to 0 °C and even below. Moreover, with rising elevation the number of summer days tends to decrease, which makes the main growing season shorter, and the number of frosty days and of those with snow cover tend to increase.

Each vertical soil zone, together with its climatic conditions, simultaneously represents a zone of ecological conditions for the vegetation and fauna (biocoenoses) and thus a zone important from the standpoint of water conservation.

Each vertical soil zone is covered by one major soil type (with the lower soil units) and several associated soil types (soil units). In this way the soil associations (pedoassociations) are formed which then make up the various soil cover structures for individual vertical soil zones.

The zones of forest vegetation are then the product of soil and climatic conditions in individual vertical zones. Structure of the soil cover in the vertical zones is responsible for the different structures of forest phytocoenoses (biocoenoses) in individual vertical zones within the ecological conditions.

The factors affecting laws that govern development of the soil cover structure are mainly the parent rock (chemical make up), phytocoenoses, climate (microclimate), relief, groundwater table, time, and human activity. In Czechoslovakia, the soil cover structure consists of the following major structural units: (1) vertical soil zones, (2) soil associations (pedogenetical and granulometrical), both natural and cultural, and (3) soil types (and the lower taxonomic soil units) and soil classes.

Each vertical soil zone consists of a definite, due combination of soil associations (pedoassociations); these are responsible for the laws that govern structure of the soil cover and thus of the phytocoenoses for the particular vertical zone of soils and vegetation. Ecological conditions of individual pedoassociations then account for the structure of species and their qualities in the particular soil zone.

Homogeneity, or heterogeneity, of the soil cover structures in respect to the pedogenic and granulometric (textural) soil associations accounts for due ranges and proportions of individual qualities of forest species in the vertical zones of soils. In Czechoslovakia there are certain differences in ecopedological parameters and quality classes of forest species found for regions of the Bohemian Upland (western Czechoslovakia) and the Carpathians (eastern Czechoslovakia).

ECOLOGICAL CHARACTERISTICS FOR VERTICAL ZONALITY OF SOILS AND FOREST VEGETATION

The zone of semigley and gley (hydromorphous) soils in the river flats extends at elevations 100—250 m approximately and is developed on Holocene river-borne sediments of the lowlands. The areas receive some 500—600 mm precipitation annually and their average annual temperatures are 8—10^0 C. The vegetation is classed with the river flat zone, or the inundated forest zone.

The zone includes mainly semigley soils, gleyed soils of the river flats, and gley soils. Distributed in the form of islets, there are also lowland peat soils, further lowland ochre-brown and grey inundated forest soils on sand dunes, these projecting above the river flats. According to grain-size distribution (texture), these soils are largely heavier — clay loams to pure clays with loamy and sandy soils being represented in smaller percentages.

These soils are slightly acid, neutral to slightly alkaline in reaction. The supplies of humus in the surface layers are largely good, ranging from 3 to

I. The average percentages of natural (forest soils) and cultivated (agricultural soils) soil types in vertical zones of the Bohemian Upland region (Czechoslovakia). — Průměrná procenta přírodních (lesních typů) a obdělávaných (zemědělských půd) půdních typů ve vertikálních zónách české vysočiny

Vertical soil zone	Soil types %	
	natural (silvicultural)	cultivated (agricultural)
1. Hydromorphous soils of lowlands	4—8	92—96
2. Chernozem soils	3—5	95—97
3. Brown forest soils of lowlands and rolling ground	10—20	80—90
4. Illimeric podzol soils of lowlands and rolling ground	20—25	75—80
5. Ochre forest soils	50—65	35—50
6. Rusty forest soils	85—95	5.15
7. Chocolate-brown forest soils	95—100	0—5
8. Mountain podzol soils	98—100	0—2

6 %. There are good to very good supplies of readily available nutrients (CaO, K_2O, P_2O_5). The regime of nitrogen and its available forms ($N\text{-}NH_3$ and $N\text{-}NO_3$) are highly favourable, too.

II. The percentages of soil classes in vertical soil zones of the Bohemian Upland region (Czechoslovakia). — Zastoupení půdních druhů v % ve vertikálních půdních zónách české vysočiny

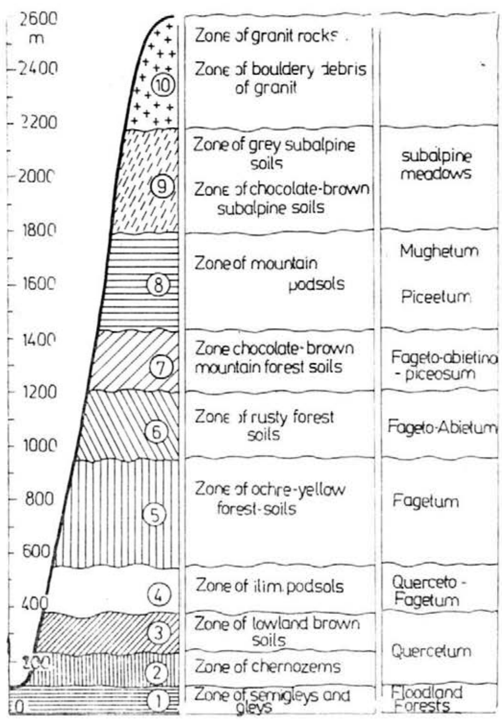
Vertical soil zone	Soils %				
	lighter 30	loams 30—45	clay loams 45—60	clayey 60—75	clays 75
1. Hydromorphous soils	3—5	25—35	35—45	15—25	5—10
2. Chernozem soils	0	55—65	15—25	10—20	10—20
3. Brown forest soils of lowlands and rolling ground	0	65—75	20—30	5—10	0
4. Illimeric podzol soils	0	60—70	30—40	0	0
5. Ochre forest soils	50—60	30—40	5—10	0	0
6. Rusty forest soils	60—70	20—30	5—10	0	0
7. Chocolate-brown forest soils	80—90	10—20	0	0	0
8. Mountain podzol soils	80—90	10—20	0	0	0

Of forest types are represented mainly: *Betuleto-Quercetum* (birch-oak forest), *Betuleto-Alnetum* (birch-alder forest), *Saliceto-Alnetum* (willow-alder forest), *Querceto-Fraxinetum* (oak-maple forest), and *Ulmeto-Fraxinetum* (elm--maple forest); all are characterized by high productions of volume.

The soil resource in this zone consists of agricultural land (about 80—90 %) and forest land (about 10—20 %).

The zone of chernozem soils extends, in the main, at elevations ranging from 120 to 300 m, the topography is flat to moderately hummocky ground. The average amount of precipitation is 500—600 mm per annum and the average annual temperatures are 8—10^0 C. The vegetation is grouped under the oak zone (*Quercetum*).

In this zone there are mainly chernozem soils on loess (both typical and carbonaceous), further islets of smolivka soils on marls, lowland chocolate-brown forest soils on loess, soil of the chernozem cast, and smaller patches of ochre forest soils on silicate soil-forming rock. In grain-size distribution, the soils are mainly loamy, a smaller proportion of them being of a lighter texture.



1. Diagram showing the vertical zones of soils and vegetation in Czechoslovakia. — Diagram vertikálních půdních a vegetačních zón v Československu

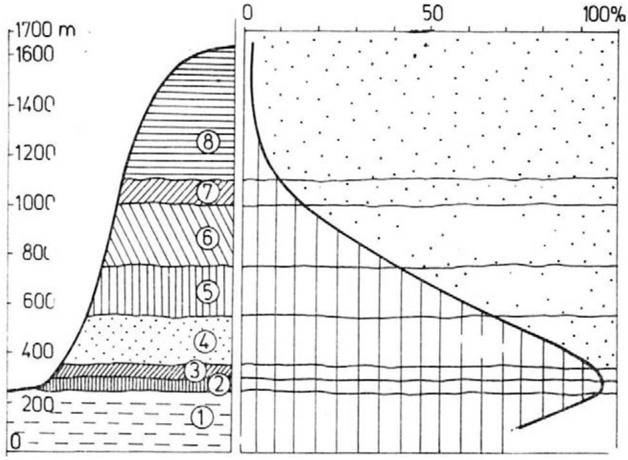
Porosity of these soils is very good, ranging from 45 to 54 % in the surface layers and from 42 to 46 % in the subsoils. The maximum capillary-water capacity is 30—40 % on the average, both in the topsoils and subsoils. The water regime is characterized chiefly by a group of dry soils (55 to 65 %), and by another group of moderately moist soils (25 to 40 %); the remaining moisture groups being represented but slightly. The soils are warm, well aerated, with the water regime aggravated during the year and with water deficits occurring especially during the latter half of the growing season.

The soils are largely neutral and slightly alkaline in reaction, the subsoils tending to medium alkalinity. Humus occurs here in medium supplies, ranging from 5 to 8 %, and the contents of readily available nutrients are very good, which in particular holds good of the reserves of available CaO. The regime of nitrogen, too, indicates good values for the contents of N-NH_4 and N-NO_3 in the top layers. Total nutrient cycling between soil and its forest stand is very good to fast (intensified mineralization of the humus).

Of forest types are represented the following phytocoenoses: *Pineto Quercetum* (pine-oak stand) on soils poor in minerals, *Carpineto-Quercetum* (hornbeam-oak stand) on soils richer in minerals, *Carpineto-Aceretum* (hornbeam--maple stand) on soils displaying favourable regimes of N, and *Corneto-Quercetum* (cornel-oak stand) on rendzina soils rich in minerals and overlying limestones.

The soil resource of this vertical zone includes agricultural land (roughly 96—98 %) and forest land (only 2—4 %). It is a distinct zone of cultured agricultural soils.

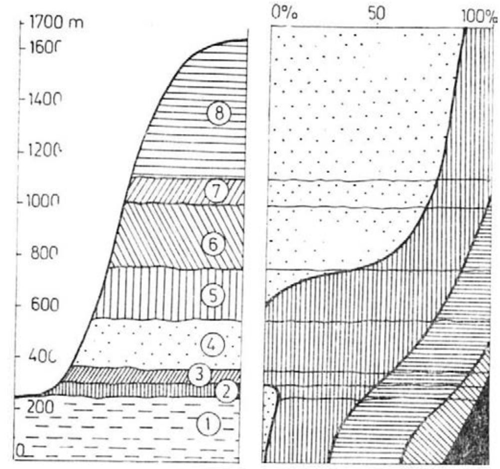
2. Diagram showing the proportions of natural (forest soils) and cultivated (agricultural soils) soil types in vertical zones of the Bohemian Upland region (Czechoslovakia). — Diagram poměru přírodních (lesních půd) a obdělávaných (zemědělských půd) půdních typů ve vertikálních zónách české vysočiny



The zone of brown forest soils occupies the lowlands and rolling ground at elevations mostly between 200 and 350 m. Its topography is slightly undulating for the most part. Concerning its climate, the zone receives 550—700 mm precipitation annually and the average annual temperatures range 7—9^0 C. The vegetation is classed with the oak zone (*Quercetum*).

The soil types found in this zone are mostly the brown forest soils of lowlands, further there are islets of degraded chernozems and illimeric (lessivé) podzols, both true and gleyed to various extents, on loessial substrates.

Of soil classes are represented mainly loams and clay loams, the brown forest soils and degraded chernozems being rather homogeneous in the profile concerning their grain-size distribution. Porosity of the surface soil layers varies between 42 and 50 %, that of the subsoils is lower, ranging from 40 to 46 %. The maximum capillary-water capacity is, on the average, 30—42 % in the surface soil layers and 30—40 % in the subsoils.



3. Diagram showing the proportions of soil classes in vertical zones of the Bohemian Upland region (Czechoslovakia). — Diagram poměru půdních druhů ve vertikálních zónách české vysočiny

From the standpoint of the water regime, represented are mostly the moisture types of dry soils (35—40 % and slightly moist soils (38—52 %) with water deficits over the growing season; the remaining moisture groups characteristic of higher water contents being represented very little. In general, this vertical zone may be characterized as suffering from water shortage over the growing season. It displays a high degree of fluctuation in the soil moisture, or in the soil water supplies, among the spring, summer, and autumn seasons, the lowest supplies being attained in the summer.

The soil resource of this vertical zone is composed of areas of agricultural land (roughly 80—90 %) and forest land (10—20 % on the average). Similarly as with the preceding zone, this one is a distinct zone of agricultural soils distinguished by an increased level of cultivation in both physical and chemical respects.

The zone of illimeric (lessivé) podzol soils is found at elevations mostly between 250 and 550 m, in the Carpathian region it reaches up to 700 m. The topography is moderately undulating and hummocky. Concerning its climate, the zone receives an amount of 600—800 mm precipitation annually and the average annual temperatures are 6—8 °C. Its vegetation is classed with the beech-oak and oak-beech transition zone (*Querceto-Fagetum*).

The soil types found in this zone are primarily illimeric podzol soils on loess and loessial loams, further islets of chocolate-brown forest soils in the hummocky parts, likewise developed on loessial substrates; and there are also ochre forest soils which occur in lesser amounts and are found on rocks of the so-called crystallinicum and on firm rocks of the younger geological formations.

In their grain-size distribution, the soils are loams and clay loams, lighter soils being represented to a lesser extent only, especially the sandy loams with minor skeletal admixtures (gravel).

The water regime may be characterized here by an appreciable proportion of slightly moist soils (44—59 %) and moderately moist soils (25—30 %). Dry soils occupy some 10—15 % only, the remaining soil moisture groups are very scarce. It is a zone the soils of which suffer from water deficit during the growing season and require supplemental irrigation, for instance to forest nurseries. The water regime indicates a highly unsettled pattern over the year, especially in its instantaneous soil moisture between the spring and summer seasons, with water deficits during the latter.

The soils are slightly to medium acid in reaction, humus occurs in the surface soil layers (3—5 %) only and supplies of available nutrients (CaO, K_2O, P_2O_5) are found in the subsoils. The topsoil layers show an appreciable impoverishment of their mineral nutrients. The processes of humification are aggravated and accumulation of the superficial, dry raw humus takes place. As a result, the biological cycling of nutrients in the soil - forest stand - soil system is slowed down as a whole.

Mainly the following phytocoenoses are found in this vertical zone of soils: *Fageto-quercinum* (normal oak-beech stand) on soils poorer in minerals and with higher acidity; *Fageto-Quercetum* and *Querceto-Fagetum* (beech-oak and oak-beech stands) on soils richer in minerals. Phytocoenoses of the types: *Carpineto-Aceretum* (hornbeam-maple stand) and *Tilieto-Aceretum* (lime-maple stand) occur on soils characterized by moderate moisture and in general good supplies of readily available forms of N. On drier soils rich in minerals there are phytocoenoses: *Corneto-Quercetum* (cornel-oak stand) and *Corneto-Fagetum* (cornel-beech stand); and *Pinetum dealpinum* has developed on moister and cooler soils.

The soil resource of this vertical zone is composed of agricultural land (about 70—80 %) and forest land (20—30 %). It is a zone of agricultural soils that display marked levels of cultivation, especially in chemical respects.

The vertical zone of ochre (brown earth) forest soils is found at elevations between 450 and 900 m, occasionally reaching up to 1100 m (in the Carpathian region). Topography of the zone is markedly dissected and of a highland character, with slopes of various aspects and deep-cut valleys in places. The amount of precipitation received per annum is 700—

-1000 mm and the annual temperatures are 5—7 °C on the average. The vegetation is grouped under the beech zone (*Fagetum*).

As the major soil type the zone includes ochre forest soils of the brown earth cast developed on various substrates, while illimeric podzols on loessial substrates are rather scarse, and occassionally there are even rusty forest soils, especially on the substrates characterized by lower content of minerals and poorer supplies of nutrients. In grain-size distribution, the soils are loams with some admixture of rock skeleton (gravel); while clay loams and lighter soils, especially sandy loams with some admixture of gravel derived from the firm soil-forming rocks, are present in smaller amounts.

The water regime may be characterized as represented by moderately moist soils that occupy an appreciable proportion in the total, ranging 60—75 %. Slightly moist soil are less frequent, some 15—20 %. This vertical zone is therefore characterized by rather good supplies of water over the year available to the forest vegetation. The water regime has, in general, a balanced pattern during the year, with no larger variations in the soil moisture among the spring, summer, and autumn seasons. The instantaneous moisture in the soil profiles likewise indicates a more balanced pattern, i. e. there are no greater differences in the moisture content between the top soil layers and the subsoils during the year.

Permeability of the soils to water and their rates of retention are rather good attaining, in forest soils, 65—75 %, whereas in agricultural soils the values are lower, ranging 15—25 % on the average. The higher rates of retention for rain water in the forest soils are due primarily to the increased instantaneous moisture level during the growing season.

Reaction of the soils is mostly medium acid (pH-H_2O 5.5—6.5), the content of humus in the surface soil layers is 4—7 % and the supplies of available nutrients (CaO, K_2O, P_2O_5) are intermediate to good, depending upon the soil-forming rocks. Mineralization of the nitrogen in the surface soil layers is good in general.

This vertical soil zone includes the following phytocoenoses: *Fagetum-quercino-abietinum* (oak-fir-beech stand) on soils poorer in minerals; *Fagetum pauper* (beech stand) and *Fagetum typicum* (typical beech stand) occur on soils characterized by larger supplies of mineral nutrients; *Tilieto-Aceretum* (lime-maple stand) on soils richer in humus and nitrogen contents; and *Fagetum dealpinum* on rich rendzina soils overlying limestones.

The soil resource in this vertical zone consists of 50—60 % forest land and 40—50 % agricultural land approximately. The zone may therefore be characterized as having roughly equal proportions of forest and agricultural soils.

T h e z o n e o f r u s t y (b r o w n e a r t h) f o r e s t s o i l s extends at elevations ranging from 700 to 1200 m. Topography of the zone is dissected, of the highland character, and with greater differences in elevations and more extensive slopes of various aspects.

As for its climate, the zone receives 900—1200 mm of precipitation annually and the average annual temperatures are 4—6 °C. The vegetation is classed with the fir-beech zone (*Abieto-Fagetum*).

The soil types that occur in this vertical zone are reprented by rusty (brown earth) forest soils, and ochre forest soils, chocolate-brown forest soils and mountain podzol soils are found in islets only. The predominating soil classes are represented by soils of a lighter cast having the content of clay particles between 20 and 30 % (sandy loams), and loams. The skeletal portion (detrital rock) is larger here, especially in the subsoils.

The soils are well to very well aerated and have a high porosity and favourable water regime. The proportion of moderately moist soils is rather high, 70—82 %. Moreover, there are also moist soils occupying 10—15 % on the average. This vertical zone has good supplies of water available to vegetation over the growing season. The water regime shows a fairly balanced pattern during the growing season, the variations in soil moisture between the spring and summer seasons being but small. The soil profiles (top soil layers and subsoils) are likewise rather homogenous in their moisture content, the differences between the upper and lower horizons are small during the growing season.

The soils are acid in reaction and their content of humus in the top soil layers ranges from 6 to 10 %. The supplies of readily available nutrients (CaO, K_2O, P_2O_5) are good. The amount of nitrogen is dependent upon the content and quality of humus for the most part; mainly the $N\text{-}NH_4$ form is represented in these soils.

Mainly the following phytocoenoses occur in this vertical zone: *Fagetum-abietino-piceosum* (fir-spruce-beech stand) on soils poorer in minerals; *Abieto-Fagetum* (fir-beech stand) on soils richer in minerals; while on soils richer in humus content and the available forms of nitrogen, phytocoenoses of the types *Fageto-Aceretum* (beech-maple stand) and *Fraxineto-Aceretum* (ash-maple stand) are found.

The soil resource of this vertical zone is characterized by predominance of forest soils occupying 70—80 %, whereas the portion of agricultural soils is much lower, about 20—30 % on the average. Accordingly, it is a mountain zone of forest soils that have a good water regime and a high water-conservation value.

The zone of chocolate-brown (brown earth) forest soils extends at elevations between 1100 and 1400 m. Topography of the zone is mountainous and dissected with an abundance of slopes and various exposures, which affects both the water and temperature regimes. As for the climate, this zone receives 1000—1300 mm precipitation annually and the average annual temperatures are 3—5 °C. The vegetation is classed with the spruce-fir-beech zone (*Fagetum-abietino-piceosum*).

Chocolate-brown forest soils represent the major soil type in this vertical zone. There are also islets of rusty forest soils, mountain podzol soils and peat soils. As the major soil classes, there are soils of a lighter character (loamy sands and sandy loams) having the clay content of 15—30 % on the average, and loams with the clay content of about 30—40 %. Both these soil classes display increased contents of detrital rock (gravel), especially in the subsoils.

The soils have a high porosity (65—75 % in the surface layers and 55—65 % in the subsoils) and very good supplies of water available to forest stands during the growing season. Moderately moist soils predominate (53—69 % areally), while moist soils occupy 20—30 % and wet soils 8—12 %.

Reaction of these soils is acid to strongly acid, the content of humus varies within a range of 8—14 % in the surface layers and 3—6 % in the subsoils. Supplies of mineral nutrients are dependent upon chemical make-up of the soil-forming rocks. A moderate accumulation of the raw moist humus occurs, the biological cycling of nutrients is slowed down in the soil - forest stand - soil system, and so is the mineralization of nitrogen from the humus.

The following phytocoenoses can be found in this vertical zone: *Fagetum-abietino-piceosum* (fir-spruce-beech stand), *Pineto-Piceetum* (pine-spruce stand), and *Piceeto-Abietum* (spruce-fir stand) on soils poorer in minerals; *Fageto-Abietum* (beech-fir stand) on soils richer in minerals. The humic soils are mostly under *Fageto-Aceretum* (beech-maple stand) and *Fraxineto-Aceretum* (ash-maple stand). The phytocoenoses *Fageto-Piceetum* (beech-spruce stand) and *Pineto-Laricetum* (pine-larch stand) are found on rendzina soils rich in minerals and overlying limestones.

The soil resource in this vertical zone is composed of forest land (95—100 %) and agricultural land (0—5 %). It is a pronounced zone of mountain forest soils.

The zone of mountain podzol soils is found at elevations 950—1800 m; in the Bohemian Upland region (western Czechoslovakia) this zone occupies areas at elevations between 950 and 1400 m, while in the Carpathian region (eastern Czechoslovakia), between 1200 and 1800 m. Topography of this zone is distinctly dissected and mountainous.

Climatically, this vertical zone receives a total of 1200—1500 mm precipitation annually and the average annual temperatures are 1—4 °C. The vegetation is classed with the spruce and dwarf-pine zones (*Piceetum + Mughetum*).

The soil types found in this vertical zone are mountain podzols (ferric, humus-ferric, and humic), further there are islets of rusty forest soils, peat soils, and peaty gleys. As for the soil classes, represented are mainly soils of a lighter character (loamy sands and sandy loams having the content of clay 15—30 %) and loams, these in a lesser extent. Both these soil classes have increased contents of detrital rock, especially in the subsoils.

Porosity of these soils is high, 65—75 % in the surface layers and 55—65 % in the subsoils; their aeration is very good, and there are very good supplies of water available to forest stands during the growing season. The following moisture types occur: moderately moist soils in an area of 38—56 %, moist soils 30—40 %, wet soils 10—15 %, and waterlogged (peat) soils 4—7 %.

The soils are acid to strongly acid in reaction. Supplies of humus in the surface soil layers are 10—15 %, whereas those of readily available nutrients are lower. Accumulation of the moist and acid superficial raw humus is conspicuous, the nutrient cycling is slowed down and the mineralization of nitrogen from the humus is low.

As for the phytocoenoses found in this vertical zone, *Sorbeto-Piceetum* (rowan-spruce stand) and *Mughetum* (dwarf-pine stand) occur on the poorer soils, *Acereto-Piceetum* (maple-spruce stand) mainly on the richer soils, and *Pineto-Laricetum* and *Mughetum calcicolum* (calcareous dwarf-pine stand) on the rendzina soils overlying limestones.

The soil resource of this vertical zone consists of forest soils (95—100 %) and agricultural soils (0—5 %). It is a pronounced zone of mountain forest soils.

Above the timber line are found the zone of brown and grey subalpine soils with grassy vegetation.

AVAILABLE NUTRIENTS

The contents of available CaO, K_2O, and P_2O_5 were determined and studied in the soils of individual vertical zones of soils and forest vegetation.

Amounts of available CaO duly decrease over the range from the lowlands to the high mountains. In the top layers of the lowland forest soils the average amounts of available CaO range from 35 to 90 mg/100 approximately and in those of the mountain forest soils the average contents of available CaO diminish to 1—6 mg/100. Accordingly, the surface layers of the mountain forest soils have about 8—20 times less available CaO than have those of the lowland forest soils. The differences in the content of available CaO between the subsoil layers of the lowlands and the high mountains are much larger; the latter having about 30—50 times less available CaO in their subsoil horizons, compared to those determined for the lowland forest soils.

Amounts of readily available K_2O diminish with rising elevation. In the top layers of the lowland forest soils the contents of available K_2O range from 15 to 30 mg/100 approximately, while in those of the mountain forest soils (except for the A_2 horizons) its amounts drop to range from 4 to 10 mg/100. Thus, the top layers of mountain forest soils have roughly 3—5 times less available potassium than have those of lowland forest soils. A marked decrease in the amounts of available potassium with rising elevation could also be detected for the superficial humus contents; in the lowlands under forest the amounts of available potassium in the superficial humus range from 26 to 35 mg/100, whereas in the mountain forest soils its amounts diminish to a range from 8 to 11 mg/100.

Amounts of available phosphoric acid reveal an appreciable decrease with rising elevation. In the surface layers of the lowland forest soils, phosphorus in available form is found in amounts ranging from 8 to 15 mg/100 on the average, whereas in those of the upland forest soils, from 2 to 7 mg/100 only, which means roughly 3—5 times less. Contents of available phosphorus likewise indicate a moderate decrease, from 14—18 mg/100 to 9—13 mg/100, for the superficial raw-humus layers with rising elevation.

The values found for readily available nutrients and, in particular, accumulation of these nutrients in the surface soil layers indicate a very good biological cycling in the lowland forest soils and a slowed down cycling in the mountain forest soils.

Over a range from the lowlands to the high mountains, the conditions of available nutrients in the forest soils suggest the following regularities:

1. The amounts of readily available CaO, K_2O and P_2O_5 tend to diminish.
2. The difference in the content of available nutrients between the top soil layers and the subsoils tends to diminish.
3. The rate of biological nutrient cycling tends to decrease.

The figures for average volues of available nutrients also indicate mutual proportions of these nutrients in individual vertical zones of soils and forest vegetation. This is of considerable importance for the recognition of laws that govern the rate of increment and the production of volume in forest stands by the vertical zonality.

The forest soils of lowlands and rolling ground (the oak and oak-beech zones) have, as a rule, the largest supplies of available CaO, intermediate supplies of K_2O and lowest reserves of P_2O_5 (CaO, K_2O, P_2O_5).

The top horizons of forest soils at the higher elevations (the beech-fir--spruce zone, the spruce zone and the dwarf-pine zone) contain, as a rule, the largest supplies of available K_2O, lower supplies of P_2O_5 and lowest reserves of CaO (K_2O, P_2O_5, CaO).

Interesting regularities could be detected between the contents of available nutrients and the water regime (instantaneous moisture in the growing season) by the vertical zonality of soils and forest vegetation:

In the forest soils of lowlands and rolling grounds (the oak and oak-beech zones) a narrower proportion is found between the total content of available mineral nutrients ($CaO + K_2O + P_2O_5$) and the average instantaneous moisture content during the summer months.

The top horizons of forest soils in the soil-vegetation zones of higher elevations (the beech-fir-spruce, spruce, and dwarf-pine zones) possess, as a rule, wide proportions between the total content of available nutrients and the instantaneous moisture content during the summer months.

In general may be said that, with rising elevation, the proportion between the amounts of available nutrients in the soils and the average instantaneous moisture content tends to become wider during the summer season.

The relationships between the amounts of available nutrients and the instantaneous moisture content are of importance for the recognition of nutrition, or nutrient uptake, by forest stands and thus also for the recognition of the dynamics of tree volume production over the year.

THE QUALITY CLASSES OF SPRUCE STANDS IN CZECHOSLOVAKIA BY THE VERTICAL SOIL ZONALITY

To obtain numerical data on the relationships between the quality classes of spruce stands and the vertical soil zonality, both existing and earlier working plans for a number of the Forest Concerns from the Bohemian Upland region, or the Bohemian Massif, western Czechoslovakia, were made use of.

The rich numerical data gathered in the above way pointed to marked relationships or correlations existing between the quality classes of spruce stands and the vertical soil (or climate-soil) zonality.

Here it seems necessary to remark that in completing a valuation of forest quality classes, the soil qualities are not taken as exclusive criteria. Fundamentally, the main indicators are in this case the valuation variables which directly follow from the stands' growth. The classification in the present study is done mostly on the basis of analyses of soil factors.

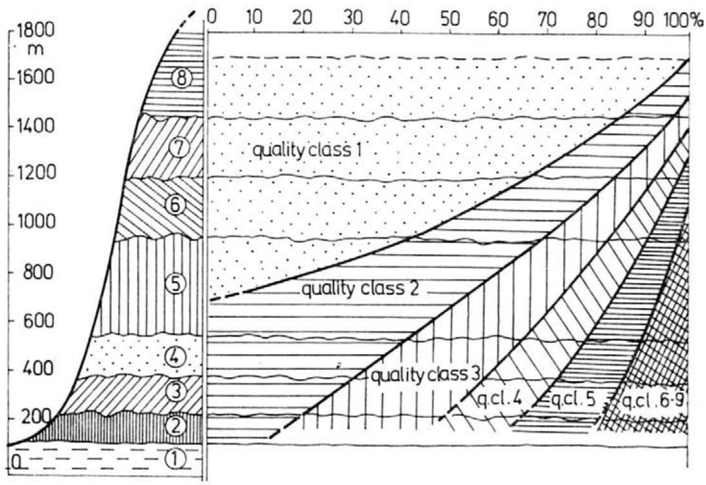
The spruce stands of quality class (1 and +1) are found in the zone of mountain podzol soils, where they occupy 85—98 % in the total of spruce stands of this vertical zone. The vegetation is classed with the spruce zone (*Sorbeto-Piceetum, Acereto-Piceetum, Fageto-Piceetum*).

In the zone of chocolate-brown forest soils the spruce stands of quality class (1 and +1) share with 65—85 % in the total, those of quality class 2 about 12—20 %, and the crops of quality class 3 with 5—8 % approximately. The vegetation is classed with the spruce-beech-zone.

In the zone of rusty forest soils, the spruce stands of quality class (1 and +1) occupy some 40—65 % in the total, those of quality class 2 share with 20—30 % and the ones of quality class 3 with 10—15 %; the still lower quality classes are represented to lesser extents in the stands. The vegetation is classed with the fir-beech zone.

III. The percentages of quality classes for spruce stands (age class V, age 80—100
Zastoupení bonitních tříd smrku v % (věková třída V, věk 80—100 let) na podkladě

Vertical soil zone	Elevation m
Brown forest soils of lowlands and rolling ground	200—350
Illimeric podzol soils	250—550
Ochre forest soils	400—900
Rusty forest soils	700—1200
Chocolate-brown soils	1100—1400
Mountain podzol soils	950—1600



4. Diagram showing the proportions of quality classes for spruce stands (age class V, age 80—100 years) by vertical soil zonality in the Bohemian Upland region (Czechoslovakia). —Diagram poměru bonitních tříd smrkových porostů (věková třída V, věk 80 až 100 let) na podkladě vertikální půdní zonality v české vysočině

In the zone of ochre forest soils, the spruce stands of quality classes 2 and 3 predominate, with a range of 40—60 % and 15—25 %, resp.; proportions of the spruce crops of quality classes 4 and 5 tend to increase, with a range of 10—15 % and 5—12 %, resp. The vegetation is grouped under the beech zone.

In the zone of illimeric (lessivé) podzol soils (the beech-oak and oak-beech transition zone), the spruce stands show the following quality classes and representations: 2, 32—45 %; 3, 20—30 %; 4, 15—20 %; and 5, 12—15 %. The proportion of quality classes 6—9 increases to 12—15 %.

In the zone of brown forest soils of lowlands (the oak zone), the spruce stands consist of material of several quality classes, but the proportion of the lower quality classes (6—9) is higher in general, ranging from 15 to 20 % in the total.

SUMMARY

In Czechoslovakia, over the range from the lowlands to the high mountains, the following sequence of vertical soil zones on silicate rocks can be traced:

years) by vertical soil zonality in the Bohemian Upland region (Czechoslovakia). — půdní zonality v české vysočině

Quality classes of spruce stands in % (age class V — age 80—100 years)					
1 and +1	2	3	4	5	6—9
0	20—30	25—35	15—25	15—20	15—20
0	32—45	20—30	15—20	12—15	12—15
0—20	40—60	15—25	10—15	5—12	3—10
40—65	20—30	10—15	5—10	2—6	0—3
65—85	12—20	5—8	0—5	0—2	0
85—98	2—10	0—5	0	0	0

1. The zone of semigley and gley soils in the river flats with inundated forests; 2. the zone of chernozem soils with phytocoenoses of the oak zone (*Quercetum*) — elevations 200—300 m; 3. the zone of brown forest soils of lowlands with phytocoenoses of the oak zone (*Quercetum*) — elevations 150—350 m; 4. the zone of illimeric (lessivé) podzol soils in lowlands and rolling grounds with phytocoenoses of the oak-beech transition zone (*Querceto-Fagetum*) — elevations 250—600 m; 5. the zone of ochre forest soils with phytocoenoses of the beech zone (*Fagetum*) — elevations 400—900 m; 6. the zone of rusty forest soils with phytocoenoses of the beech-fir zone (*Fageto-Abietum*) — elevations 700—1200 m; 7. the zone of chocolate-brown mountain forest soils with phytocoenoses of the beach-fir-spruce zone (*Fageto-abieto-Piceetum*) — elevations 1200—1500 m; 8. the zone of mountain podzol soils with phytocoenoses of the spruce and dwarf-pine zones (*Piceetum + Mughetum*) — elevations 950—1800 m; 9. above the timber line are the zones of meadow, brown and grey subalpine soils, and still higher, the top zone of detritus and stones; 10. the zone of stones — elevations above 2000—2200 m.

Each vertical soil zone, together with its climatic conditions, simultaneously represents a zone of ecological conditions for the vegetation and fauna (biocoenoses) and thus a zone highly important from the standpoint of water conservation.

The zones of forest vegetation are then the product of soil and climatic conditions in individual vertical zones. Structure of the soil cover in the vertical soil zones is responsible for the different structures of forest phytocoenoses (biocoenoses) in individual vertical zones within the ecological conditions.

Over a range from the lowlands to the high mountains, the conditions of available nutrients in the forest soils suggest the following regularities: 1. The amounts of readily available CaO, K_2O, and P_2O_5 tend to diminish. 2. The difference in the content of available nutrients between the top soil layers and the subsoils tends to diminish. 3. The rate of biological nutrient cycle tends to decrease.

The abundant numerical data gathered from this study revealed existence of marked relationship or correlations between the quality classes of spruce stands and the vertical soil (or climate-soil) zonality.

Here it seems necessary to remark that in completing a valuation of forest quality clases, the soil qualities are not taken as exclusive criteria. Fundamentally, the main indicators are in this case the valuation variables which directly follow from the stands'growth. The classification in the present study is done mostly on the basis of analyses of the soil factors.

Thus, the spruce stands of quality class (1 and +1) are found in the zone of mountain podzol soils, where they occupy 85—98 % in the total of spruce stands of this vertical soil (or climato-soil) zone.

In the zone of chocolate-brown forest soils, the spruce stands of quality class (1 and +1) share with 65—85 %, those of quality class 2 take about 12—20 % in the total.

In the zone of rusty forest soils, the spruce stands of quality class (1 and +1) occupy some 40—65 %, those of quality class 2 take 20—30 %, and the crops of quality class 3 represent some 10—15 % in the total.

In the zone of ochre forest soils, the spruce stands of quality classes 2 and 3 predominate, with a range of 40—60 % and 15—25 %, respectively; proportions of the spruce stands of quality classes 4 and 5 tend to increase, with a range of 10—15 % and 5—12 %, respectively, in the total.

In the zone of illimeric (lessivé) podzol soils occur spruce stands of the following quality classes and representations: 2, 32—45 %; 3, 20—30 %; 4, 15—20 %; and 5, 12—15 % in the total.

In the zone of brown forest soils of lowlands, the spruce stands consist of material of several quality classes, but the proportion of the lower quality classes (6—9) is higher in general, ranging from 15 to 20 % in the total.

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Ekologické poměry výškové půdní pásmitosti ve vztahu k bonitám smrkových porostů české vysočiny

V Československu je na silikátových horninách tento sled výškových půdních pásem (z nížin do hor):

1. Pásmo půd semiglejových a glejových v nivních rovinách údolních řek s lužními lesy, 2. pásmo černozemí (200—300 m) s fytocenózami dubového pásma (*Quercetum*), 3. pásmo hnědých lesních půd nížinných s fytocenózami dubového pásma (*Quercetum* 150—350 m), 4. pásmo nížinných a pahorkatinných ilimerických podzolů (250—600 m) s fytocenózami přechodného pásma dubo-bukového (*Querceto-Fagetum*), 5. pásmo okrových lesních půd (400—900 m) s fytocenózami bukového pásma (*Fagetum*), 6. pásmo rezivých lesních půd (700—1200 m) s fytocenózami bukovo-jedlového pásma (*Fageto-Abietum*), 7. pásmo čokoládově hnědých horských lesních půd (1200—1500 m) s fytocenózami bukovo-jedlovo-smrkového pásma (*Fageto-abieto-Piceetum*), 8. pásmo horských podzolů (950—1800 m) s fytocenózami smrkového a klečového pásma (*Piceetum* + *Mughetum*), 9. nad horní hranicí jsou již pásma lučních půd hnědých a šedých subalpínských, pak vrcholová pásma sutí a skal, 10. pásmo skal ve výškách nad 2000—2200 m.

Jednotlivá výšková půdní pásma spolu s poměry klimatickými představují výšková pásma ekologických podmínek pro vegetaci a živočišstvo (biocenózy) a zároveň výšková pásma velmi důležitá po stránce vodohospodářské.

Produktem půdních a klimatických poměrů jednotlivých výškových pásem jsou pak vegetační lesní pásma. Struktura půdního pokryvu výškových půdních pásem podmiňuje různou strukturu lesních fytocenóz (biocenóz) v jednotlivých výškových pásmech v rámci ekologických poměrů.

Poměry přístupných živin v lesních půdách od nížin do horských oblastí vykazují tyto zákonitosti: 1. klesání přístupného CaO, K_2O a P_2O_5, 2. zmenšování rozdílu v obsahu přístupných živin mezi svrchními a spodními vrstvami půd, 3. snižování intenzity biologického koloběhu živin.

Bohatý číselný dokumentační materiál ukázal výrazné závislosti nebo korelace mezi bonitami smrkových porostů a výškovou půdní (resp. klimaticko-půdní) pásmitostí.

Je třeba poznamenat, že při komplexní taxační bonitaci neuvažují se jen vlastnosti půdy. V podstatě jsou v tomto případě hlavními ukazateli taxační veličiny, jež vyplývají přímo z růstu porostů. Klasifikace v této práci je provedena převážně na podkladě rozborů půdních faktorů.

Smrkové porosty první bonity (1 a +1) se nalézají v pásmu horských podzolů, kde tvoří 85—98 % smrkových porostů tohoto výškového půdního, resp. klimaticko-půdního pásma.

V půdním pásmu čokoládově hnědých lesních půd jsou tvořeny smrkové porosty první bonitou (1 a +1) ze 65—85 %, porosty druhé bonity jsou tu zastoupeny asi 12—20 %.

V pásmu rezivých lesních půd jsou tvořeny smrkové porosty první bonitou ze 40—65 %, druhou bonitou z 20—30 % a třetí bonitou z 10—15 %.

V pásmu okrových lesních půd převládají smrkové porosty druhé bonity (40 až 60 %) a třetí bonity (15—25 %) a zvyšuje se zastoupení čtvrté bonity (10—15 %) a páté bonity (5—12 %).

V pásmu ilimerických podzolů jsou zastoupeny smrkové porosty druhé bonity 32—45 %, třetí bonity 20—30 %, čtvrté bonity 15—20 % a páté bonity 12—15 %.

V pásmu hnědých lesních půd nížin jsou tvořeny smrkové porosty několika bonitami s celkově zvýšeným podílem horších bonit (6.—9. bonita) v rozmezí 15 až 20 %.

Экологические отношения высотной почвенной зональности и класса бонитета еловых насаждений в области чешской возвышенности (западная часть ЧССР)

В области Чехословакии на силикатных горных породах можно наблюдать следующую последовательность почвенных зон (от низменностей до гор):

1. зона глеевых и семиглеевых почв в равнинных долинах рек и пойменных лесов; 2. зона черноземов (200—300 м) с фитоценозами дубовой зоны (*Quercetum*); 3. зона бурых лесных почв низменных с фитоценозами дубовой зоны (250—350 м) (*Quercetum*); 4. зона низменных и холмистых иллимерических подзолов (250—600 м) с фитоценозами переходной зоны (буково-дубовой и дубово-буковой) (*Querceto-Fagetum*); 5. зона охровых лесных почв (400—900 м) с фитоценозами буковой зоны (*Fagetum*); 6) зона ржавых лесных почв (700—1200 м) с фитоценозами буково-пихтовой зоны (*Fageto-Abietum*); 7. зона шоколадно-бурых горных лесных почв (1200—1500 м) с фитоценозами буково-пихтово-еловой зоны (*Fageto-abieto-Piceetum*); 8. зона горных подзолов (950—1800 м) с фитоценозами еловой и косостланниковой зоны (*Piceetum* + *Mughetum*); 9. над лесной границей располагаются зоны луговых почв бурых и серых субальпийских, дальше вершинная зона осыпей и скал; 10. зона скал в высоте над 2000—2200 м.

Отдельные высотные почвенные зоны совместно с климатическими условиями представляют высотные зоны экологических условий для вегетации и фауны (биоценозы) и одновременно высотные зоны, очень важные с водохозяйственной точки зрения.

Продуктом почвенных и климатических отношений отдельных высотных зон являются лесные вегетационные зоны. Структура почвенного покрова высотных почвенных зон в свою очередь обуславливает разную структуру лесных фитоценозов (биоценозов) в отдельных высотных зонах в рамках экологических отношений.

Отношения доступных питательных веществ в лесных почвах от низменностей до горных областей показывают следующую закономерность: 1. Снижение доступного CaO, K_2O и P_2O_5. 2. Уменьшение разницы в содержании доступных питательных веществ между верхними и нижними слоями. 3. Снижение интенсивности биологического круговорота питательных веществ.

Богатый числовой документальный материал указывает на выразительную зависимость или корреляцию между бонитетами еловых насаждений и высотной почвенной (эвент. климатическо-почвенной) зональностью.

Следует отметить, что при комплексной таксационной бонитировке учитываются не только свойства почвы. По существу в данном случае главными показателями являются таксационные величины, вытекающие непосредственно из роста насаждений. Классификация в данной работе произведена преимущественно на основе анализов почвенных факторов.

Ökologische Verhältnisse der vertikalen Bodenzonalität und die Bonitätsgrade der Fichtenbestände im Gebiet Böhmischem Hügelland (westlicher Teil der ČSSR)

Auf den Silikatgesteinen im Gebiet der Tschechoslowakei kommt diese Folge vertikaler Bodenzonen vor (von den Niederungen bis ins Gebirge): 1. Zone der Semigley- und Gleyböden in den Auenebenen der Talflüsse mit den Auenwäldern; 2. Zone der Schwarzerden (von 200 bis zu 300 m ü. NN) mit Phytozönosen der Eichenstufe (*Quercetum*); 3. Zone brauner Niederungswaldböden mit Phytozönosen der Eichenstufe (von 150—350m) (*Quercetum*); 4. Zone der illimerischen Niederungs- und Hügellandspodsole (von 250—600m) mit Phytozönosen einer Übergangsbuchen Eichenstufe und Eichen-Buchenstufe (*Querceto-Fagetum*); 5. Zone der Ockerfarbigen Waldböden (von 400—900m) mit Phytozönosen einer Buchenstufe (*Fagetum*); 6. Zone der Rostfarbigen Waldböden (von 700—1200m) mit Phytozönosen der Buchen-Tannenstufe (*Fageto-Abietum*); 7. Zone der Schokoladenbraunen Gebirgswaldböden (von 1200—1500m) mit Phytozönosen der Buchen-Tannen--Fichtenstufe (*Fageto-abieto-Piceetum*); 8. Zone der Gebirgspodsole (von 950—1800m) mit Phytozönosen der Fichten- und Latschenstufe (*Piceetum + Mughetum*); 9. Oberhalb der Waldgrenze kommen schon die Zonen der braunen und grauen subalpinen Wiesenböden vor, ferner dann das Gipfelgebiet von Schutz und Felsen; 10. Felsenzone in den Höhenlagen von über 2000—2200 m ü. NN.

Die einzelnen vertikalen Bodenzonen mit den klimatischen Verhältnissen stellen die vertikalen Zonen der ökologischen Bedingungen für die Vegetation und Tierwelt (Biozönosen) sowie auch wasserwirtschaftlich sehr wichtige vertikale Zonen dar.

Ein Produkt der Boden- und Klimaverhältnisse der einzelnen vertikalen Zonen sind dann die Waldvegetationsstufen. Die Struktur der Bodendecke von vertikalen Bodenzonen bedingt dann eine unterschiedliche Struktur von Waldphytozönosen (Biozönosen) in den einzelnen vertikalen Zonen im Rahmen der ökologischen Bedingungen.

Die Verhältnisse der aufnehmbaren Nährstoffe in den Waldböden weisen von den Niederungen ab bis in die Gebirgsgebiete folgende Gesetzmäßigkeiten auf: 1. Sinken des CaO-, K_2O-, P_2O_5- Gehaltes. 2. Verminderung der Unterschiede im Gehalt an aufnehmbaren Nährstoffen zwischen den oberen und unteren Bodenschichten. 3. Verminderung der Intensität des biologischen Nährstoffkreislaufs.

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A CONTRIBUTION TO THE DEVELOPMENT OF AN AUTOMATED METHOD OF INFORMATION SYSTEM ANALYSIS

Further improvement and perfectioning of the existing information systems, without which modern business management is simply unthinkable, has come to the focus of attention of virtually all sectors of our national economy.

The above problem had to be attached also by the staff of the Forestry and Game Management Research Institute, Strnady, when working on the research project „Analysis of Economic Information Systems for Czechoslovak State Forests", the objective of which was to develop a suitable economic information system based on computer processing, that would provide a reliable background for a better decision-making and management of forestry operations on a nation-wide level.

The steps leading to the final solution were as follows: description of the information system, analysis of the information system, and design of a new system on a pre-project level.

Considerable comprehensiveness of the problem, i. e. thousands of partial processings, a variety of interior and exterior relationships, characteristics of partial processing parameters and information made it necessary to develop simultaneously with the on-going work on the project, and hand in hand with some other organizations, a comprehensive automated method for the analysis and synthesis of information systems (Palla, Hřebíček, Dejmek 1973).

Of the whole project, the Forestry and Game Management Research Institute's staff worked methodically on the following sub-projects:

1. Data collection for description of the information system,
2. Automated development of the matrix model of the information system,
3. Analysis of parameters and relationships of the information system.

The highly taxing programming-analytical processing was performed by the staff and undergraduates of the Computer Centre, Prague School of Economics. The respective programs are in ALGOL 4120, the computer used was NCR ELLIOTT 4120, Prague School of Economics; those who are interested may obtain programs from the above institution.

DESCRIPTION OF METHODS FOR REPRESENTATION OF INFORMATION SYSTEMS

In the system analysis, adequate description of a system under study is of paramount importance, and in relation to the information systems, several methods heve been developed:

1. Network representation of information system models. This approach is based on the theory of graphs, and has been applied to represent graphically the sequential processes (Č e r n j a k 1968).

2. System representation utilizing information storage and retrieval technique, e. g. the AFIS method (S m r č i n a 1972).

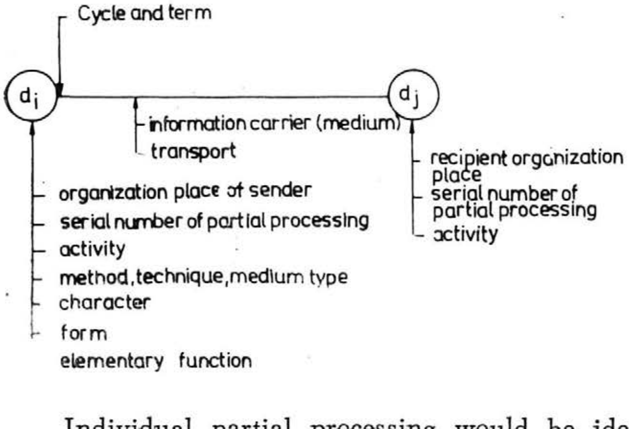
3. Representation of relationship hierarchy between media and information, and their searching using a bill of material processor BOMP, e. g. the ADIS method (Č á p 1971).

4. An interesting approach to representation of the information systems is the technique based on concrete information (contrary to the type of information used in the abovedescribed systems). Also in this case, a graph is used for basic representation, yet in the graph nodes are stored the simulated concrete data of specified information types (H u g g i n s 1960). Here belong for instance the automated methods like MODS (H i r š 1971), and UNIS, simulating the data base (M i l á č e k 1971).

5. Among the projected representation forms of information systems may be included the models described in the problem oriented non-algorithmic system languages of economic information, e. g. in the SJAIN language, developed by the Central Institute of Economics and Mathematics, Soviet Academy of Sciences (K r u g l i k o v, S a j e n k o 1970).

A SHORT DESCRIPTION OF THE METHOD USED

The development of an automated method for the analysis and synthesis of information systems is based on the relationship between directed graphs and matrices (H ř e b í č e k 1969). The information system in question would be represented as a graph the nodes of which are the partial processings (transformations of input to output information), and on the edges of which are defined the information media (information vectors), and the time of their transport.



1. Elementary partial processings relationship. — Elementární vztah dílčích zpracování

Individual partial processing would be identified on the basis of classification, relation, and causal analyses of the respective information system, each partial processing being characterized in greater detail by its parameters, e. g. by the activity class of the function sub-system, cycle and term of processing, method of management, processing technique, nature and form of processing, and name of the elementary function of the working regulations.

In practical application, the information system analysis would be greatly simplified when using its matrix form enabling employment of automated algebraic methods.

The basic element of the information system model in the approach submitted adopted is the relationship between the partial processings, represented by information connection. This relationship is pictured, along with the respective parameters, in Fig. 1.

DATA COLLECTION FOR DESCRIPTION OF THE INFORMATION SYSTEM

The method of data collection, which is being developed, is oriented on the matrix form representation of the information system to be studied. It consists of two phases:

— inventory and description of information carriers (media), and the storage of their items in the form of a file of data base,

— automated formation of inputs records of the matrix model.

INVENTORY AND DESCRIPTION OF MEDIA

This is a preparatory phase, in the course of which the (information) media would be collected, i. e. form of standard series, and non-standard ones, also the available oral information and communication would be recorded, etc. All media would be identified this way, semantic duplications would be removed, the respective medium characteristics would be classified (medium type, its validity and obligatory), and each medium would be entered in a medium master file sheet (see Fig. 2).

Identification No.	Formalized medium name	Current medium name	Medium type	Medium validity and obligatory
Number of characters 4	21	40	1	1

2. Medium Master file sheet. — Formulář matričního souboru nositelů informací

Identification number would be assigned according to a group-serial key of code, preferably on the basis of function sub-systems.

Formalized name would be formed from the main name prescribed by the syntax: subject, verb, object, adverb of mode, place, and time, respectively.

Current name would be taken from the respective form name or, it would be standardized.

Medium type, its validity and obligatory would be coded in accordance with the adopted code of the information system.

The master file would be handled like other data base files, i. e. it would be read, cleared (in our particular case according to alphabetic sequence of formalized names), and stored in the external computer memory. The file may be changed when necessary.

The medium master file would be prepared invariably by a staff member of the executive agency.

AUTOMATED FORMATION OF INPUT RECORDS FOR THE MATRIX MODEL

This phase follows the survey of the information system used by the studied organization. The results of the survey, i. e. identified partial processings, along with their characteristic values, and identified information relationships would be entered in a Partial processing and information sheet. Each indvidual partial processing will have its own sheet, and it will be taken as a block of the final output, of the necessary inputs, and/or non-final outputs, respectively. Such a sheet, in the modification of the Prague School of Economics, may be seen in Fig. 3.

The partial processing sheets would be first ordered by the analyst on the basis of their time and subject matter relationships, and thereafter would they be punched. Also direct input of the above sheets into a computer was studied, yet since there is no suitable device in this country to do the job (which could be done e. g. by the IBM Optical Page Reader 1288, scanning also the hand-written data), the partial processing sheet was not considered as a record for direct reading, which might be of course very advantageous.

After introduction of the partial processing sheet data, the compupter makes automatically the records of partial processing blocks, and the data entered in the sheets are being completed with those of the medium master file according to the program. Other data prescribed would be given on the basis of program statements.

The symbols characterizing recording of different relationships are given in Tab. I.

The records would be then printed, by the respective partial processing blocks, as follows:

1 — Check Copy of Records

The records would then undergo a standard system of formal and logical controls and corrections, and the errors found would be removed on the basis of a

2 — List of Errors of Records

by a special repair computer job.

AUTOMATED INFORMATION SYSTEM MATRIX MODEL COMPUTATION

Automated information system matrix model computation proceeds in three successive steps, namely

— transfer relationship consistence test,
— development of fictitious relationships,
— development of matrix model input records.

THE TRANSFER RELATIONSHIP CONSISTENCE TEST

A check of the transfer relationship consistence is based on the conclusion that

Block
a
0|0|1

3. Partial processing and information sheet. — Záznamový list dílčích zpracování a informací

State Forest Directorate: Teplice
State Forest Farm: Dubí
Department: Sales Dept. Head

Organization place		Activity	
Name	b	Name	c
Sales Dept. Head	0|3|5|0|1	Check	1|7|2|2

Description of partial processing

Check of delivery receipt LM 04

Cycle and term d_i				Elementary function	
Name	h	ch	*i*	Name	*j*
Daily	6	2|1	0|0|0|0	Check	7|0|0

Decision making method		Computing technique		Character		Form	
Name	d	Name	e	Name	f	Name	
None	0	None	0		0	None	0
Logic	1	Manual	1	Decision disposit.	1	Fact-finding	1
Lin. progr.	2	Small mech.	2	Decision approv.	2	Adjustment	2
	3	Medi. mech.	3	Indep. rout.	3	Conversion	3
	4	Great mech.	4	Mech. rout.	4	Merging	4
Network. analysis	5	Automation	5			Num. transf.	5
Struct. analysis	6		6			Summarisation	6
	7		7			Comparison	7
Mat. stat.	8		8			Examination	8
Other	9		9			Other	9

Input information			Sender of input information				Cycle and term				Transport	
Name	k	l	Name	m	n	o	Name	p	q	r	Name	s
Delivery receipt LM 04	|7|6|5	1	Transport Head	0|0|5|0|1	) (	|			|	|||		
Number code key KMV	|6|0|5	1	Own	0|3|5|0|1	) P (	3|9	Daily	6	2|1	0|0|0|0	Personally	1
Transport distance alloc.	1|8|3|4	1	Own	0|3|5|0|1	) P (	4|1	Daily	6	2|1	0|0|0|0	Personally	1
	|||	1		||||	) (	|			|	|||		
	|||	1		||||	) (	|			|	|||		
	|||	1		||||	) (	|			|	|||		
	|||	1		||||	) (	|			|	|||		

Output information				Receiver of output information				Transport		
Name	t	u	v	Name	w	x	y	Name	z	
Delivery receipt LM 04	|7|6|5	0	) V (	Own	0|3|5|0|1	) (	|	Personally	1	
	|||	0	) (		||||	) (	|			
	|||	0	) (		||||	) (	|			
	|||	0	) (		||||	) (	|			
	|||	0	) (		||||	) (	|			
	|||	0	) (		||||	) (	|			
	|||	0	) (		||||	) (	|			1

I. List of symbols for records computation. — Přehled symbolů pro vytváření záznamů

Relationship type / Record column			1	2	3	4	5	6	7	8	9	10	11	12	13	14				15	16	17	18	19	20	Note
Input		Reality — Block*)	P	m	o	c	p	q	r	K	k	e	b	O	P	d	s	K	e	f	g	a	j	K	P	*) for each *i*-th medium, *i*-th sheet of the same block
Input		Enviroment — Block	P	m	o	O	p	q	r	K	k	e	b	O	c	O	s	K	O	O	O	a	O	K	O	
Input		Storage — Block	P	m	P	O	p	q	r	K	k	e	b	O	c	O	O	O	O	O	O	a	O	K	O	
Input		Block — Block	P	m	O	O	O	O	O	K	k	e	b	O	c	O	O	O	O	O	O	a	O	K	O	
Output	result	Block — Block	P	b	O	c	h	ch	i	K	t	u	w	O	O	d	z	K	e	f	g	a	j	K	P	
Output	result	Block — Storage	P	b	O	c	h	ch	i	K	t	u	w	P	O	d	z	K	e	f	g	a	j	K	P	
Output	result	Block — Environment	P	b	O	c	h	ch	i	K	t	u	w	y	O	d	z	K	e	f	g	a	j	K	P	
Output	non result	Block — Block	P	b	O	c	h	ch	i	K	t	u	w	O	O	O	z	K	O	O	O	a	O	K	O	
Output	non result	Block — Block	P	b	O	c	h	ch	i	K	t	u	w	P	O	O	z	K	O	O	O	a	O	K	O	
Output	non result	Block — Environment	P	b	O	c	h	ch	i	K	t	u	w	y	O	O	z	K	O	O	O	a	O	K	O	

Legend: a—z ...... data set from the record lists, spaces denoted a—z
P .... program-set data
K .... program-set data from the medium master file
*) in order to record the activity of data collection from reality

— any block transfer output must have within a given information system a corresponding transfer input of a subsequent block (pair-block);

— this rule may be checked using the method of information searching according to key;

— any disturbance of the transfer relationship consistence must be discovered, printed, identified as to its nature, and/or removed.

The method of information searching according to key (associative searching) is based on the principle that when looking for a certain information, we need not know in which cell of the computer memory it is stored. The address of the storage cell containing the desired information does not result from the program, but that particular storage cell is going to be found, the contents of which corresponds with some earlier known key. Consequently, the address where a certain information is stored is given by the respective information itself or by its part — keys (Krajzmer, Matjuchin, Majorkin 1971).

In the transfer relationship consistence testing, the following key-words would be used as key-bytes:

2 — Organization place (of the sender)
8,9,10 — Medium
11 — Organization place (of the recipient)

All records of the model enter into the transfer relationship consistence test, and the objective is to assess their transition levels, and to find out their corresponding pair records. The records having no pair counterparts would be printed as follows:

3 — List of Errors in Pair Relationships

On the basis of this list, the errors within the model would be identified, and according to their nature they would be either removed or left unchanged. The repairs would be recorded in line with the rules of repair job, and would be effected by the same repair procedure.

DEVELOPMENT OF FICTITIOUS RELATIONSHIPS

Fictitious partial processing and edges that must be introduced in some instances to obtain a satisfactory matrix model may be made by the computer. The idea is that fictitious relationship must be formally introduced in those cases when at least two different media enter a partial processing, and result from it (leave it) at least two different media, of which at least one is identical with one of the entering (input) media[1]).

One of the alternative designs and functioning of fictitious nodes and edges is represented schematically in Fig. 4.

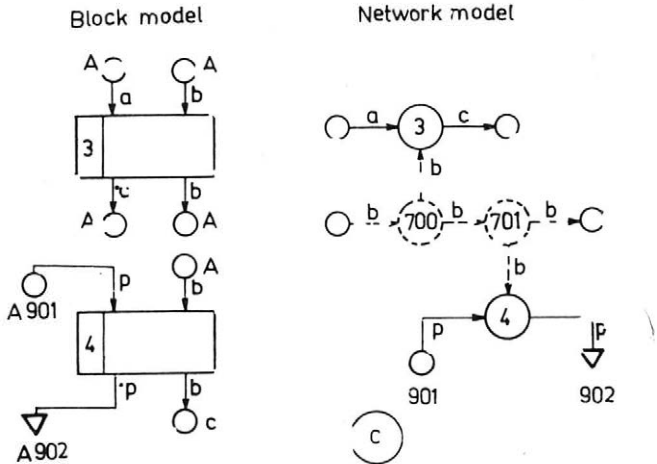
The fictitious nodes are marked with the respective partial processing numbers

$$900 > d_i \geq 700$$

and the fictitious edges are represented by broken lines.

[1]) At present, the program produces fictitious relationships in those instances when at least two different media are put out of a single partial processing, while at least one medium identical with some of the output-media is put in.

4. Computation and function of fictitious relationships. — Tvorba a funkce fiktivních vazeb



Automated computation of fictitious nodes and relationships proceeds according to a general flow chart pictured in Fig. 5.

The data content of records with computed fictitious nodes and that of fictitious records would be computer-counted and filled according to Tab. II.

DEVELOPMENT OF INPUT RECORDS FOR THE MATRIX MODEL

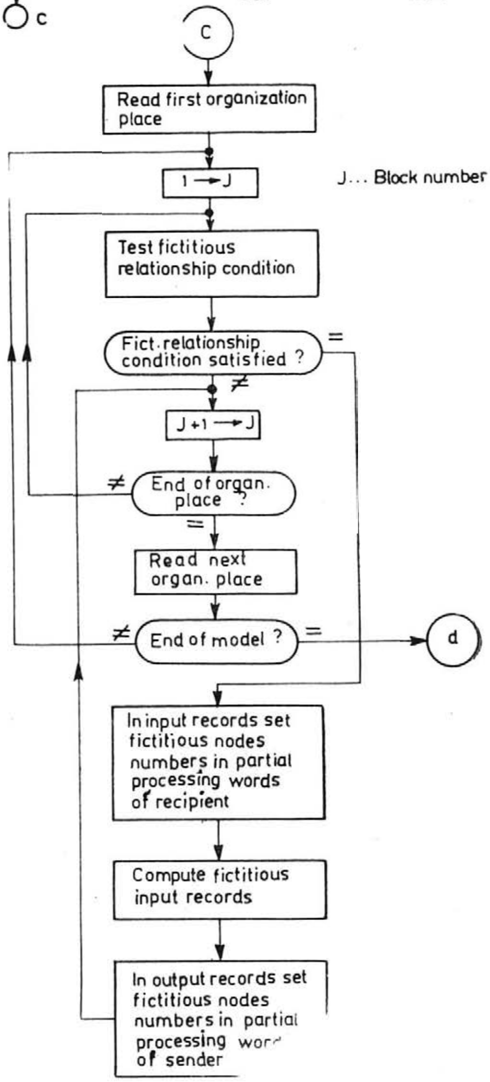
After the making and completion of fictitious nodes and records, a full record set would be obtained which would be processed by the computer into the input records of the matrix model.

The program involves first the testing of relationship transition levels, and then follows two different ways:

— in the non-transition records fills the blank spaces of partial processings with the block numbers,

— in the transition records, pair-records would be sought in line with the relationship consistence test program, and the block numbers would be again set in the partial data processings according to the respective algorithm.

The pair records would be merged in one record by transferring the



5. Generalized flow chart of fictious relationship computation. — Hrubé blokové schéma tvorby fiktivních vazeb

input record data to the output, and the input record in question would be cancelled. The partial data processings would be linked this way.

II. Table for computation of fictitious nodes and edges. — Tabulka pro výpočet

Output / Input	$d_i - d_j$	System	d_i	Activity	Cycle + term	Medium	System
	Record column	2	3	4	5—7	8—10	11
Output	700—1	X	700	0	X	X	X
	700—902	X	700	0	X	X	X
	700—Ok	X	700	0	X	X	X
Input	901—700	X	X	0	X	X	X
	700—1	X	700	0	X	X	X
	1—700	X	0	0	0	X	X
	Ok—700	X	X	0	X	X	X

III. Check copy of records — Example of list No. 1. — Vzor sestavy č. 1 — Kontrolní

1 — Punch card check copy (items copy)

Rec. No.	System	DI	Activity	Cycle + Term			Medium			System	DJ
1	2	3	4	5	6	7	8	9	10	11	12
Organization place			Supply Dept Head		State Forest Farm			03501			
3	00501	000	0000	0	00	0000	2	0765	1	03501	000
5	03501	939	0000	6	21	0000	4	0605	1	03501	000
7	03501	941	0000	6	21	0000	4	1834	1	03501	000
9	03501	000	1722	6	21	0000	2	0765	0	03501	000
11	00501	000	0000	0	00	0000	2	0766	1	03501	000
13	03501	939	0000	6	21	0000	4	0605	1	03501	000
15	03501	941	0000	6	21	0000	4	1834	1	03501	000
17	03501	000	1722	6	21	0000	2	0766	0	03501	000
19	35010	000	0000	0	00	0000	2	0765	1	03501	000
21	03501	000	0000	0	00	0000	2	0766	1	03501	000
23	03501	000	1681	6	21	0000	4	1885	0	03501	000
25	35628	000	0000	0	00	0000	2	1688	1	03501	000
27	03501	943	0000	6	21	0000	3	1668	1	03501	000
29	03501	945	0000	6	21	0000	3	1811	1	03501	000
31	03501	000	1657	6	21	0000	3	1668	0	03501	944
33	03501	000	1657	6	21	000	2	1688	0	03501	000
35	03501	000	0000	0	00	0000	2	1688	1	03501	000
37	03501	939	0000	6	21	0000	3	1947	1	03501	000
39	03501	947	0000	6	21	0000	3	1751	1	03501	000
41	03501	000	3761	6	21	0000	2	1688	0	03501	000

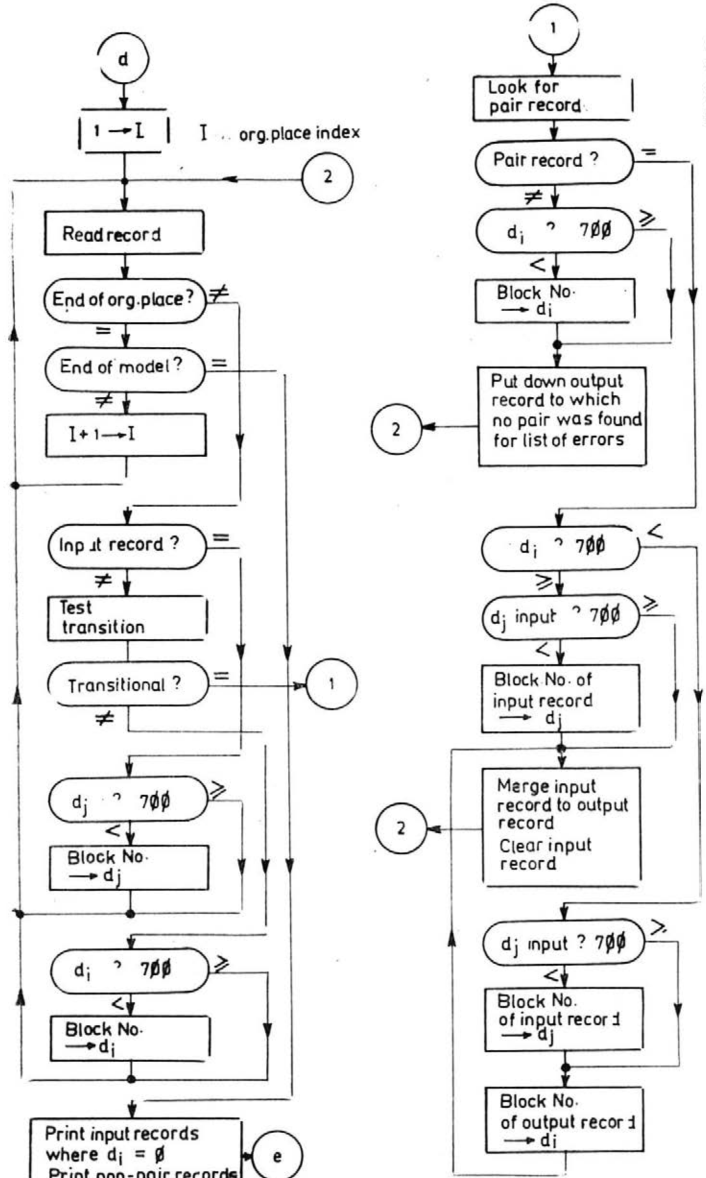
From this program, the generalized flow chart of which is pictured in Fig. 6, result the input records of the information system matrix model.

fiktivních uzlů a hran

d_j	Activity	MŘ	ME + TE TR	DN	VT	Character	Form	Block No.	ELF CE	ABC media	ABC ELFCE
12	13	14				15	16	17	18	19	20
0	0	X	1	X	X	X	X	X	X	X	X
X	0	0	1	X	0	0	0	X	0	X	0
X	0	0	X	X	0	0	0	X	0	X	0
700	0	0	X	X	X	0	0	X	0	X	0
1	0	0	1	X	0	0	0	X	0	X	0
700	0	0	0	0	0	0	0	X	0	X	X
700	0	0	X	X	0	0	0	X	0	X	0

opis záznamů

Activity	M + T	CH	Form	Block	ELF	Medium and function name	
13	14	15	16	17	18	19	
1722	0000	0	000	001	000	Delivery receipt LM04	
1722	0121	0	000	001	000	Number code key EMV	
1722	0141	0	000	001	000	Transport distance	
0000	1131	3	347	001	700	Delivery receipt LM04	—CHE
1722	0000	0	000	002	000	Delivery receipt LM05	
1722	0121	0	000	002	000	Number code key EMV	
1722	0141	0	000	002	000	Transport distance	
0000	1131	3	347	002	701	Delivery receipt LM05	—CHE
1681	0000	0	000	003	000	Delivery receipt LM04	
1681	0000	0	000	003	000	Delivery receipt LM05	
0000	1121	4	346	003	300	Stock total from LM04, LM05	—PRF
3761	0000	0	000	004	000	Invoice	
3761	0131	0	000	004	000	Record of supply orders	
3761	0121	0	000	004	000	Supply orders	
0000	1121	4	346	004	500	Record of supply orders	—EVD
0000	0120	0	000	004	000	Invoice	
3761	0000	0	000	005	000	Invoice	
3761	0121	0	000	005	000	Code numbers	
3761	0121	0	000	005	000	Invoice draft	
0000	1121	3	347	005	702	Invoice	—CHE



6. Generalized flow chart of model development. — Hrubé blokové schéma tvorby modelu

The input records would be both stored for the purpose of further automated processing, and printed in the form of a list:

4 — Matrix Model by Organization Places

to be used by the analyst.

ANALYSIS OF PARAMETERS AND RELATIONSHIP OF THE INFORMATION SYSTEM

In line with the present methodological approach to design of automated management systems, an analysis of the information system constitutes a part of the so-called pre-project phase.

The first analytical step performed on the model of the information system is an analysis of its parameters and relationships. This analysis makes it possible to entirely classify, learn, and examine the basic characteristics of the information system studied, as well as their interrlationships, features, and common qualities. On this basis, its subsystems may be judged, and the central element of the system may be identified at which the subsequent analytical steps will be aimed, i. e. a thorough functional analysis, and design of a new information system.

It should be pointed out that automation of the analytical operations involved in the developing method is at the moment confined essentially to automated processing of background data for the analysis proper, while automated design of an optimum system has not yet been attempted.

The background data for analysis, representing a basis for the design of an automated information system, are as follows:

— analysis of partial processing frequency,
— analysis of relationship frequency,
— analysis of qualitative parameters of partial processings

IV. List of errors of records. Example of list No. 2. — Vzor sestavy č. 2. — Kontrolní sestava chyb záznamů

2 — Check list of punch card (items) errors		
In record No.	33 is zero value in item	7
In record No.	51 is zero value in item	7
In record No.	59 is zero value in item	7
In block No.	5 is error in result output information	
To output record No.	103 no input record was found	
In record No.	169 is zero value in item	7
In block No.	5 is output information missing	

ANALYSIS OF PARTIAL DATA PROCESSING FREQUENCY

To carry out an analysis of partial processing frequency, the following lists were computed:

— Analysis of partial data processing frequency relating to individual business operations. The list provides an information on the number of partial processing on different business operation pattern levels, and through a relative comparison of individual data we arrive at conclusions regarding balanced or imbalanced business operations in general.

— Analysis of partial processing frequency relating to specified jobs and departments, and the list provides again a picture of the partial processing distribution, this time relating to organization places (functions, divisions, departments, etc.). A comparison of relative data is important in the judgement of activities and responsibilities of individual organization places.

V. List of errors in pair relationships — Example of list No. 3. — Vzor sestavy č. 3
Check list of errors in pair relationships

Rec. No.	System	DI	Activity	Cycle + Term			Medium			System	DJ
1	2	3	4	5	6	7	8	9	10	11	12
3	00501	000	0000	0	00	0000	2	0765	1	03501	000
9	03501	000	1722	6	21	0000	2	0765	0	03501	000
11	00501	000	0000	0	00	0000	2	0766	1	03501	000
19	35010	000	0000	0	00	0000	2	0765	1	03501	000
23	03501	000	1681	6	21	0000	4	1885	0	03501	000
41	03501	000	3761	6	21	0000	2	1688	0	03501	000
53	35628	000	0000	0	00	0000	4	1924	1	35601	702
55	35601	000	1676	6	21	0000	3	1785	0	35627	000
65	35601	000	1671	5	25	0500	4	1925	0	36901	000
73	35628	000	0000	0	00	0000	4	0969	1	35601	000
77	35601	000	1684	5	41	2000	2	1909	0	87000	000
79	35601	000	1684	5	41	2000	2	1909	0	35601	000
85	35628	000	0000	0	00	0000	2	1692	1	35625	000
87	35628	000	0000	0	00	0000	3	1714	1	35625	000
113	35625	703	1657	5	41	3000	3	1813	0	35625	000
125	35625	701	1657	5	41	3000	1	1759	0	35625	000
133	35628	000	3762	6	21	0000	2	1693	0	03501	000
135	35628	000	3762	6	21	0000	2	1693	0	03271	000
137	35601	000	0000	0	00	0000	3	1784	1	35628	000
171	35628	000	3762	6	21	0000	3	1670	0	35628	000

ANALYSIS OF RELATIONSHIP FREQUENCY

The analysis of relationship frequency provides the following information:

— Analysis of business activity relationships.

The list contains the respective relationship frequencies (on the basis of information exchange) between individual business activity levels, and it permits us to study the relative closed or open nature of individual business activities, the relationship between the business activity classes and the so-called business agenda, and the extent to which is the existing business agenda division justified from the viewpoint of the system.

— Analysis of organization place relationships

This list provides a review of the information relationship frequency (information exchange) existing among individual organization places (functions and departments) on different management levels. This gives us a tool to study how far are the individual departments or management posts closed or open with regard to communication among them, and to compare this with the need of minimum external interaction.

— Analysis of business activity and organization place relationships

This list provides a picture of the information relationship frequency be-

— Kontrolní sestava chyb v párových vazbách

Page 1

Activity	M + T	CH	Form	Block	ELF	Medium and function name
13	14	15	16	17	18	19
1722	0000	0	000	001	000	Delivery receipt LM04
0000	1131	3	347	001	700	Delivery receipt LM04
1722	0000	0	000	002	000	Delivery receipt LM05
1681	0000	0	000	003	000	Delivery receipt LM04
0000	1121	4	346	003	300	Stock total from LM04, LM05
0000	1121	3	347	005	702	Invoice
1676	0000	0	000	002	000	Delivery record
0000	1111	1	348	002	100	Management instructions
0000	8162	4	346	003	300	Delivery record (%)
1684	0000	0	000	005	000	Monthly forest production delivery record
0000	1461	4	347	005	700	Monthly forest production delivery record
0000	1161	4	347	005	700	Monthly forest production delivery record
3671	0000	0	000	001	000	Invoice according to loading list Cards L-55
3671	0000	0	000	001	000	
0000	0120	0	000	003	000	Export delivery order
0000	0120	0	000	005	000	Order
0000	1433	4	345	001	300	Invoice for un-delivered timber
0000	1433	4	345	001	300	Invoice for un-delivered timber
3762	0000	0	000	002	000	Invoicing data
0000	1121	4	346	005	303	Invoice recording

tween the business activity classes and organization places (divisions, functions) on different management levels. It represents a tool to follow the organizational attachment of business activities, and the parts played by individual departments and divisions in the management and administration business activities.

ANALYSIS OF QUALITATIVE PARAMETERS

The analysis of qualitative parameters of partial processings provides the lists on the partial processing shares for specified parameters in the management and administration objective classes, and the most important lists of this type are as follows:

— Analysis of partial processing periodicity

The list is derived from the cycle and terms of partial processing, and it draws attention of the analyst to activities of higher periodicity, i. e. more important from the view-point of automated management system designs.

— Analysis of partial data processing types

This list informs both on the share of individual data processing types in the respective classes of management and administration objectives, and on the

VI. Matrix model by organization places — Example of list No. 4. — Vzor sestavy Matrix model by organization subsysteme

Rec. No.	System	DI	Activity	Cycle + Term			Medium			System	DJ
1	2	3	4	5	6	7	8	9	10	11	12
141	35628	903	0000	6	21	0000	3	1811	1	35628	003
143	35628	905	0000	6	21	0000	1	1840	1	35628	003
145	35628	907	0000	6	21	0000	2	0004	1	35628	003
151	35628	003	3762	6	21	0000	2	1688	0	99016	004
157	35628	907	0000	6	21	0000	2	0004	1	35628	004
159	35628	909	0000	6	21	0000	3	1784	1	35628	004
161	35628	911	0000	6	21	0000	1	1840	1	35628	004
163	35628	004	3762	6	21	0000	2	1688	0	35628	914
166	35628	702	0000	0	00	0000	2	1688	1	35628	005
167	35628	915	0000	6	21	0000	3	1670	1	35628	005
17	03501	003	0000	0	00	0000	2	0766	0	03501	003
25	35628	003	3762	6	21	0000	2	1688	1	03501	003
33	03501	701	0000	0	00	0000	2	1688	0	03501	005
57	35601	002	0000	0	00	0000	3	1785	0	35625	002
59	35601	702	0000	0	00	0000	4	1924	0	35601	703
67	35601	703	0000	0	00	0000	4	1924	0	35601	004
101	35625	003	0000	0	00	0000	3	1813	0	35625	703
103	35625	701	0000	0	00	0000	1	1760	0	35625	702
111	35625	702	0000	0	00	0000	1	1760	0	35625	004
139	35628	003	0000	0	00	0000	3	1784	0	35628	003
153	35628	004	0000	0	00	0000	2	1688	0	35628	004
165	35628	005	3762	6	21	0000	2	1688	1	35628	005

other hand, in its columns are entered the shares of individual management and administration objective classes in the respective partial processing type groups. So far greatest attention has been paid to the field of routine partial processing, yet the proportion of decision-making partial data processings may be more closely specified by way of automation, and it is here where the computer techniques may be used on a much greater scale.

The other analytical list — analysis of management methods, medium types, computer technique, and partial processing form may be made upon request. These will be useful particularly in the information systems in which the qualitative parameters listed above feature a more variable pattern.

CONCLUSIONS

In this paper an attempt hase been made to describe the procedures involved in an automated method of information system analysis and synthesis, as developed by the Forestry and Game Management Research Institute, Strnady, in the process of work on the research project "Analysis of Economic Information Systems for Czechoslovak State Forests".

Activity	M + T	CH	Form	Block	ELF	Medium and function name
13	14	15	16	17	18	19
3762	0133	0	000	003	000	Delivery order
3762	0123	0	000	003	000	Tax rates
3762	0123	0	000	003	000	Price list
0000	1433	4	345	003	302	Invoice
3762	0121	0	000	004	000	Price lists
3762	0131	0	000	004	000	Invoicing data
3762	0121	0	000	004	000	Tax rates
0000	1131	4	347	004	700	Checked invoice
3762	0000	0	000	005	000	Invoice
3762	0121	0	000	005	000	Invoice record
0000	0000	0	000	003	000	Delivery receipt LM05
3761	1433	4	345	003	302	Invoice
0000	0000	0	000	005	000	Invoice
0000	0000	0	000	002	000	Management instructions
0000	0000	0	000	003	000	Delivery record
0000	0000	0	000	004	000	Delivery record graph
0000	0000	0	000	003	000	Delivery instruction exp.
0000	0000	0	000	003	000	Export order
0000	0000	0	000	004	000	Export order
0000	0000	0	000	003	000	Invoicing data
0000	0000	0	000	004	000	Invoice
3762	0120	0	000	005	000	Invoice

The subject matter may be divided essentially in two problem areas:

— The first objective was to develop by way of automation an information system matrix model with formal and logic check, and with a test of consistence of transfer relationships.

— The second objective was to develop a method of automated processing of data for the first phase of information system analysis — analysis of its parameters and relationships. The results of this phase — definition of the subsystem contents, and choice of the central system element, — serve along with a detailed description of the model as a basis for further detailed analytic and synthetic work.

The method was used by the Strnady Forestry and Game Management Research Institute in the first stage of analysis of the information system as practised by the Czechoslovak State Forests. The method enabled to chose and to justify on the basis of statistical evidence a central element of the business information system — management information system. Its detailed description served as a basis for:

functional analysis of the management information system,
design of an automated management information system,
estimating the impact of the changes proposed on the present information system.

To meet the objectives of this second phase of research, other methods of analysis and partly also synthesis were developed, and their improvement and perfectioning has been under way.

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Příspěvek k tvorbě automatizované metody analýzy informačního systému

V lesním hospodářství, podobně jako v jiných resortech, se v současné době řeší problém racionalizace informačního systému v souvislosti s potřebou prohloubení řídících a správních činností a zavádění elektronické výpočetní techniky.
V lesním hospodářství byly aplikovány exaktní automatizované metody analýzy řídícího informačního systému založené na jeho maticovém zobrazení.
V průběhu řešení úkolu byly analyticky rozpracovány součásti metody směřující k vytvoření komplexního souboru inženýrských metod automatizovaného projektování informačních systémů. V popisované etapě šlo o oblast automatizo-

vané tvorby maticového modelu informačního systému se zabudovanými formálními a logickými kontrolami a testem vnitřních přechodových vazeb prvků systému a oblast automatizovaného zpracování podkladů prvního kroku analýzy informačního systému — analýzy jeho parametrů a vazeb.

Automatizovaná tvorba maticového modelu má tyto části: sběr a dokumentační zpracování nositelů informací a vytvoření matričního souboru, analogického souboru dat datové základny; popis informačního systému — jeho uzlů (dílčích zpracování) a hran (informačních vazeb) s jejich parametry na záznamovém formuláři vhodném pro děrování vstupních médií počítače; automatizované vytvoření vstupních záznamů maticového modelu, jejich logická a formální kontrola a oprava opravným chodem; tvorba fiktivních vazeb, sřetězení dílčích zpracování a vytvoření vstupních záznamů maticového modelu pro další zpracování na počítači.

Automatizovaně zpracovávané podklady pro analytickou práci jsou přehledy a tabulky umožňující analyzovat parametry a vazby informačního systému s cílem návrhu nového informačního systému.

Výběr podkladů je volitelný a zpracovávají se zejména sestavy: četností dílčích zpracování organizačních míst a podnikových činností; četností vazeb mezi podnikovými činnostmi, mezi organizačními místy a mezi podnikovými činnostmi a organizačními místy; četností výskytů různých kvalitativních parametrů dílčích zpracování, např. periodicit zpracování, charakterů a forem dílčích zpracování aj.

Hlavní součásti této metody byly využity při analýze a návrhu automatizace řídícího informačního systému podniku Státních lesů.

О создании автоматического метода анализа информационной системы

В лесном хозяйстве, как и в других ведомствах, ныне решается проблема рационализации информационной системы в связи с потребностью углубления управленческой и административной работ и внедрения электронно-вычислительной техники.

В лесном хозяйстве были применены экзактные автоматические методы анализирования информационной системы управления на базе матричного изображения.

В ходе решения задания были аналитически разработаны составные части метода, направленные на создание комплекса инженерных методов автоматического проектирования информационных систем. В описанном этапе следующие области: автоматическое образование матричной модели информационной системы с встроенными формальными и логическими контролями и тестом внутренних переходных связей элементов системы; автоматическая разработка отправных данных к первому шагу анализа информационной системы — анализа ее параметров и связей.

Автоматическое образование матричной модели разделяется на следующие части: сбор и документационная обработка носителей информации, образование матричной гарнитуры, аналогической гарнитуры данных банка; описание системы — ее узлов (частных обработок) и граней (информационных связей), параметров на формуляре описаний, пригодном для перфорации входных носителей ВМ; автоматическое образование входных описаний матричной модели, их логический и формальный контроль, правка правочным ходом; образование фиктивных связей, сцепление частных обработок и создание входных описаний матричной модели для дальнейшей обработки на ВМ.

Автоматически обработанные материалы для аналитической работы — это обзоры и таблицы, позволяющие анализировать параметры и связи информационной системы в целях проектирования новой системы.

Материалы можно выбрать, обрабатываются, главным образом, следующие системы: частоты частных обработок организационных мест и деятельности предприятий, частоты связей между деятельностью предприятий, между организационными местами и между деятельностью предприятий и организационными местами, частоты нахождений разных возможных качественных параметров частных обработок, напр. периодичностей обработок, их характера и форм и пр.

Главные части метода были использованы при анализе и проектировании автоматизации информационной системы управления предприятием Гослесов.

Beitrag zur Gestaltung der automatisierten Methode für Informationssystemanalyse

Ähnlich wie in den anderen Ressorts wird in der Forstwirtschaft gegenwärtig das Problem der Informationssytemrationalisierung im Zusammenhang mit der Notwendigkeit einer Vertiefung der Leistungs- und Verwaltungstätigkeiten sowohl der Einführung der elektronischen Rechentechnik gelöst.

In der Forstwirtschaft wurden exakte automatisierte Methoden für die Analyse des leitenden Informationssystems, die dessen Matrixdarstellung zur Grundlage haben, eingesetzt.

Während der Lösung der Aufgabe wurden die Bestandteile der, auf die Bildung eines vollkommenen Komplexes der technischen Methoden der automatisierten Informationssystemprojektierung gerichteten Methode analytisch bearbeitet. In der beschriebenen Etappe handelte es sich um folgende Gebiete: automatisierte Gestaltungen des Matrixmodelles des Informationssystems mit eingebauten formalen und logischen Kontrollen und einem Test der inneren Übergangsbindungen der Systemelemente; automatisierte Unterlagenverarbeitung für den ersten Schritt der Informationssystemanalyse — der Analyse seiner Parameter und Bindungen.

Die automatisierte Gestaltung des Matrixmodells besteht aus den folgenden Teilen: Ansammlung und Dokumentationsverarbeitung der Informationsträger und die Schaffung des Matrixkomplexes, des analogischen Datenkomplexes der Datengrundlage; Beschreibung des Informationssystems — seiner Knotenpunkte (Teilverarbeitungen) und Kanten (Informationsbindungen) und ihre Parameter auf dem für die Lochung der Inputmedien des Rechners geeigneten Aufzeichnungsformular; automatisierte Schaffung der Inputaufzeichnungen des Matrixmodells, ihre logische und formale Kontrolle und Korrektur durch den Korrekturgang; Schaffung der Fiktivbindungen;Verkettung der Teilverarbeitungen und Schaffung der Inputaufzeichnungen des Matrixmodells für weitere Verarbeitung mit dem Rechner.

Automatisiert verarbeitete Unterlagen für die analytische Arbeit sind Übersichten und Tafeln, die eine, auf den Vorschlag eines neuen Informationssystems gezielte Analyse der Parameter und der Informationssystembindungen ermöglichen.

Die Auswahl der Unterlagen ist wahlbar und es werden insbesondere die folgenden Zusammenstellungen verarbeitet: der Häufigkeiten der Teilverarbeitungen der Organisationsstellen und der Betriebstätigkeiten, der Häufigkeiten der Bindungen zwischen den Betriebstätigkeiten, zwischen den Organisationsstellen und zwischen den Betriebstätigkeiten und den Organisationsstellen, der Häufigkeiten der Vorkommen verschiedener Qualitätsparameter der Teilverarbeitungen, z. B. der Verarbeitungsperiodizitäten, der Teilverarbeitungencharakter und -formen u. a.

Die Hauptbestandteile dieser Methode wurden bei der Analyse und bei dem Entwurf der Automatisierung des leitenden Informationssystems des Betriebes Staatswälder ausgenutzt.

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PROGRESSIVE TECHNOLOGIES IN FINAL FELLINGS OF ČSR

In recent years, Czechoslovak forestry has failed to keep pace with some advanced countries in the field of logging techniques, and this fact has been apparent particularly with regard to productivity, mechanization of difficult manual logging operations, management of the entire timber harvesting process, and integration with the timber industries, respectively.

Should forest management in this country go forward as an important segment of the national economy at large, the resultant unbalance caused by its slowed down technological development is to be removed. These technological and economic problems and objectives, leading to the implementation of the ultimate goals of forest management, i. e. to sustained yield and exploitatión of the nation's forest resources and promoting of all forest influences, should be approached and resolved by way of better management and particularly systematic technological development.

The major targets are considered to be higher productivity, better efficiency, and improved work hygiene and safety. The first target — technological improvement and higher productivity of the existing logging techniques, adapted to the current silvicultural systems and management methods — was approached as Phase I solution — improvement of the logging operations on the basis of conventional equipment, while in the Phase II the targets outlined would be attempted by considering up-to-date sophisticated logging equipment and the associated logging techniques, as well as the resultant implications with regard to State Forest Farms, etc.

As for the final input-output analysis, the result of itis assumed to be of relative economic significance since the purchasing prices of the imported equipment samples cannot be related to the actual inputs (e. g. in comparison to our tractor industry price levels); it is of course expected to be very informative for the purpose of a relative comparison among the logging procedure alternatives and different imported equipment designs.

A specific feature of the problems is that the ultimate aim is not only higher productivity, better economy, and ergonomic aspects, but that the answers sought must fit into the typical partial cutting silvicultural system which is considered as providing all the benefits and influences man can derive from sound management of forest resources.

The solution to the problem cannot be thus found by a mere importation of sophisticated high-performance equipment proven on large-scale clear-cut forest operations in certain advanced countries, but it is imperative to design the logging procedures that would, apart from meeting the targets of productivity, cost saving ,and ergonomy, be feasible also from the view-point of the partial cutting silvicultural system, as well as of the finer ones based on more demanding forest reproduction methods.

PRESENT LOGGING METHODS IN THIS COUNTRY AND ABROAD

The principal logging operations, i. e. tree felling, limbing, and bucking are carried out by one-man chain saws, the design and performance characteristics of which and operation had been constantly improved, which has enabled the extension of their application also to felled tree limbing.

The present logging operations in this country are based either on the one--man-logging (the woodcutter fells, limbs, and/or grades the trees, and bucks them into the timber grades required), or on a continuous logging performed by the felling crews ensuring the production process consisting normally of the sequences tree felling, limbing, bunching (skidding), and production of grade logs on the landing site.

A necessary prerequisite of the two logging systems is the all-year-round timber supply (o. b., the barking to be done at the mill).

The power saws have become the most common logging tool because of simplicity of design, light weight, operational dependability, satisfactory performance, versatility, and particularly low purchasing price, despite of the statistical figures showing also their drawbacks, e. g. excessive noise and vibration (International Seminar on Working Conditions in Forestry and on Forest Labour Health, 1972, Prague).

Intensive development of mono- and multi-purpose logging equipment perfectioning the so far existing logging systems has been under way for several years in the countries advanced in forest management and forest engineering, and its more recent models are as follows:

Machines for tree felling and log bunching: LP-2 and LP-19 (UdSSR), Kockum 880 (Sweden), Drott (USA), Tree Farmer, Koehrung KFB-3 (Canada).

Machines for tree felling, limbing, and bunching: Caterpillar 950 (USA), Pika 75 (Finnland).

Machines for tree felling and yarding: Volvo 868, with the ÖSA 640 felling head (Sweden), VTM-4 (UdSSR).

Machines for limbing und bunching: SM-2, LP-15, LUČ-2 (UdSSR), Logma, Sund, Bronemo (Sweden), HA-35 (GDR).

Machines for limbing, bucking, sorting, and bunching: ÖSA 705, ÖSA 710, Volvo SM 880, Kockum 875-78 (Sweden), Pika 50 (Finland).

A technologically separate group is represented by the machines and equipment limbing standing trees, and apart from the Beloit Tree Harvester (Canada), experiments have been under way with the portable limbing and barking machine (system Serias) intended for thinning stands, which is based on the design of the Sachs K 31 limbing saw, with the limbing parts added. In the process of work on the research project "Technological Development" at the Research Station Křtiny, an equipment for limbing of standing trees has been designed, which is mounted on a tractor of the 2nd unified range.

As for the logging operations in coniferous old-growth stands, particular attention has been focused on the equipment turning out rough logs (tree-length logs) at the stump or on the roadside landing, their logging characteristics being in agreement with the development concepts and projections of Czechoslovak forestry.

For the purpose of log bucking, the ÖSA 770 (Sweden) bucking saw has been developed abroad, which is mounted on the hydraulic forks, and is a component of the modified grapple. It is either an implement of the log skidding unit, used in felled tree bucking before they are bunched out of the stand, or is it mounted on the truck undercarriage to buck and pile the trees well ahead before loading them onto the hauling vehicles.

The log conversion on the roadside landings would be effected by the log conversion unit Kapverk (Sweden).

THE LOG CONVERSION ON THE ROADSIDE LANDINGS WOULD BE EFFECTED BY THE LOG CONVERSION UNIT KAPVERK (SWEDEN)

Universal wheeled tractors. Replacement of the obsolete tractor stock (represented by the out-producing Zetor-Super 50 models) has been under way in the Czech Socialist Republic, the newer models of the unified range I being introduced, at the moment the tractor Zetor 5511, and since 1974 the models Zetor 6718 and 6748, respectively. Projected is the introduction of the Zetor 8045, and also Zetor 14045 tractors of the unified range II.

Special forestry wheeled tractors. From among the available special forestry tractors, it is Kockum KS 821 (Sweden), Timberjack 209 D (Canada), and Tees Martin LKT-75 that have been operated in the Czech Socialist Republic. The prevalling logging technique is log bunch skidding, and the above special forestry tractors serve mostly 3 to 6-man logging teams doing the felling, limbing, skidding, and log conversion on roadside landings.

Apart from the special forestry tractors, also the Volvo 868 (Sweden) skidding unit and its modifications for logs and bucked tree-lengths have been field-tested as under the above research projects in the forests operated by the State Forests Directorate Krnov, State Forest Farm Bruntál. Also nine Volvo 462 (Sweden) skidding units have been imported, and these have been employed in harvest and thinning cutting operations.

In a number of foreign countries special forestry tractors have been used for a couple of years; these are e. g. Valmet 880 and 880 S, Lokkeri (Finland), Kockum KS 821 and 861 (Sweden), Latil T-4-T (France), Caterpillar 518, Clark 666 and 664, Pay Logger S-9 (USA), Timberjack 209 D, 240 D, 360, 404 (Canada), and the skidding units Valmet 880 K, Lokkeri Forwarder (Finland), Volvo 868, Kockum KS 836-45, KS 836-46, KS 850 (Sweden), Cemet (France), etc.

In spite of the fact that it is wheeled tractors that have been given preference in the forests of the Soviet Union (TDT 55, TB-1, TDT-75, TT-4), increasing attention has been given also to pre-production testing of the K-703, T-127 wheel tractors and of a more powerful T-127 tractor derived from the latter model. In Romania, a special forest wheel tractor started rolling from the assembly lines (TAF 65).

TIMBER TRUCKING (LOADING AND UNLOADING)

The by far commonest log truck in Czechoslovakia has been Praga V3S, the capacity of which is 5 Mp. In recent years has been the ageing truck fleet improved by addition of new medium-capacity trucks (7 to 8 Mp), Tatra 138 NT 4 X 4, and Škoda 706 RTTNP (the latter truck being used in forest operations either as a truck or a towing vehicle).

The models named above can be supplied with the DA-5 and DA-7 (DA-10) semi-trailers, bunks jaws for the towing vehicle, electric semi-trailer controls enabling safe and easy operation of the unit when transporting long logs, and double-drum winches for the loading of tree-lenght logs and/or log sections.

Since 1971, hydraulic grapples (tongue) have been used, and imports of the Fiskars 6000 (Finland) model which is suitable for all log trucks having at least a 7 Mg capacity, have begun. These would be used in loading of long logs, and in this case are they mounted just behind the driver's cabin, as well as in loading short-length logs and timber; in the latter case would they be mounted on the extended flatcar, and this way they can also serve when required the attached trailer.

For the purpose of timber unloading at the consumers' yards (log conversion yards of State Forest Farms), the following equipment would be employed: a) yard equipment (rail or mobile cranes), b) front loaders Volvo LM 620 or 640, HON 050, and according to the projections, UNC-151, c) hydraulic grapples (tongues).

In the Soviet Union, 10 Mg, 15 Mg, and 23 Mg-capacity carriers would be used for the log delivery from the forest.

The trucking of logs or tree lengths on surfaced roads would be done by way of the 15 Mg-capacity carrier MAZ 509, equipped with the 2 LT trailers, or the TMZ 803 four-wheel semi-trailers. If no logs are carried, the semi-trailer would be put onto the towing vehicle by the winch.

The heaviest-duty log carrier (23 Mg) in Kraz 255 L, equipped with a four-wheel semi-trailer TMZ 803. This carrier that can handle full-length trees up to 30 m long, may be operated along metalled all-weather roads only, and during the no-load turns would the semi-trailer be borne on the towing vehicle.

Loading of tree logs onto log carriers would be effected in the Sowiet Union by means of heavy-duty log stackers, mounted on caterpillar and in recent years also on wheeled tractors.

The trees would be delivered for further processing in most cases to central log yards, and unloaded by runway cranes of a maximum capacity of 20 Mg, their limbs being removed on stationary limbing units MSG or PSL, respectively.

Depending on the final product (timber grade) and place of log conversion, the logging-conversion technique would be based on: 1. short-timber method, 2. tree-length logs method, 3. full-tree method.

In the Scandinavian countries, the short-timber method prevails; after a certain slight decline (80 per cent of all logging) it has again regained its earlier position (85 per cent), which has been due to advanced design, manufacturing, and large-scale employment of multi-purpose forest equipment tailored for this method. The proportion of the tree-length log method is some 14 per cent, wheares the full-tree logging accounts for some 1 per cent or so.

In the Soviet Union, preference has been given to the full-tree logging, followed by further log processing on big-capacity central log bucking and conversion yards.

In Austria, the so called Ernlezug logging procedure has been developed and practiced, consisting in the bucking, and conversion plus grading of felled trees on forest log depots.

DESCRIPTION AND PROJECTIONS OF NEW LOGGING TECHNIQUES IN THE CZECH SOCIALIST REPUBLIC

The objective of our investigations was to work out feasible projections of new logging techniques for harvest cuts in coniferous forest stands under different regeneration systems (cuttings), specifying the best-suitable equipment, detailed description of the procedure proper, labour required, expected productivity, and the necessary prerequisites of economic, manpower skill, and organizational nature, which in combination would raise the logging productivity by 15 to 25 per cent against the 1970 level.

It follows from the above that the factors that must be taken into consideration when designing the logging techniques meeting the pre-set objectives, may be classed as follows: environmental and operational conditions, conditions resulting from the present forest management and silvicultural systems used in Czechoslovakia, conditions governed by labour productivity, economics, and safety.

It is therefore necessary to characterize the recommended logging techniques in terms of indices (parameters, limits) that might be compared with the above-given conditions from the view-point of suitability and index value required. To this end, a procedure described in the project methodology has been used in our logging technique projections.

Various basic figures used in the compilation and projection work have been obtained from earlier observations, as well as from expert assessment, and/or on the basis of the still valid performance standards; in some cases foreign data relating to similar conditions were used, and these were processed in the conventional way.

The figures that are intended as a basis of production cost calculation (for the purpose of relative comparisons on the same level among different logging techniques) have been computed according to empirical formulae approved as part of this research project methodology (Š t a u d, D r e s s l e r, Š k a p a 1971). Consequently, for instance the cost of manual logging per cu. m. according to the above-mentioned methodology is

$$N_{\text{cu. m.}} = \frac{160}{V} \text{ Kčs},$$

where 160 Kčs is estimated present one shift cost (basic wage, bonuses, social allowance, travel allowance, food allowance, wage rise deduction ,social security contribution, etc.), V — per shift performance in cu. m., equivalent to 115 per cent norm fulfilment (for equipment where no productivity standards are yet available, this is a reliable estimate).

The cost of tree felling and limbing with a JMP chain saw would be calculated on the above basis according to the formula

$$N_{\text{cu. m.}} = 2 + \frac{160}{V} \text{ Kčs}.$$

The cost of log bucking and conversion was taken as expressed by this formula

$$N_{cu.\,m.} = 0.7 + \frac{160}{V}\ \text{Kčs.}$$

For the machine operation the following formula was found and accepted

$$N_{cu.\,m.} = \frac{\frac{A\,C}{R\,.\,200} + B + 160\,P}{V}\ \text{Kčs,}$$

in which A – Coefficient depending on a particular machine kind $A = O + 1$.

O – Aggregate repair cost throughout the entire machine life, related to the purchasing price. This ranges from 100 to 250 per cent of the latter, and in the Praga V3S log trucks is 200 per cent or more, in the universal tractors 200 per cent, in the special forestry tractors 100 per cent of the purchasing price, etc.

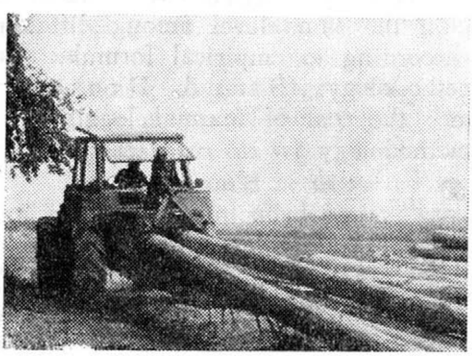
C – Purchasing price of equipment.

R – Equipment life in this country is considered to be 8 years on the average (it is much less abroad), on the other hand, we count with a high repair cost, including capital repairs, approaching the price of a new machine.

B – Total cost of fuel, lubricants, tyres, and other material inputs per shift. This cost is almost equal for individual machine type groupings; that for log conversion lines is 60, for universal tractors 100, for special more powerful forestry tractors 200 and more, for special limbing machines 500 and more, respectively.

P – Number of labourers.

With regard to the fact that certain differences in future development of the logging techniques are likely to be expected both because of technological progress and varying production conditions, the existing basic logging techniques has been taken as a standard (result of the first research stage), and successively more advanced techniques featuring better technical and economic parameters have been projected, their economics and feasibility being expressed simultaneously in terms of parameters and limits determined by the respective environmental and silvicultural operating conditions.



1a. Log skidding by hydraulic grapple mounted on universal tractor Z 14045 (Technique no. 2). – Soustřeďování dřeva drapákovým závěsem na univerzálním traktoru Z 14045 (technologie č. 2)

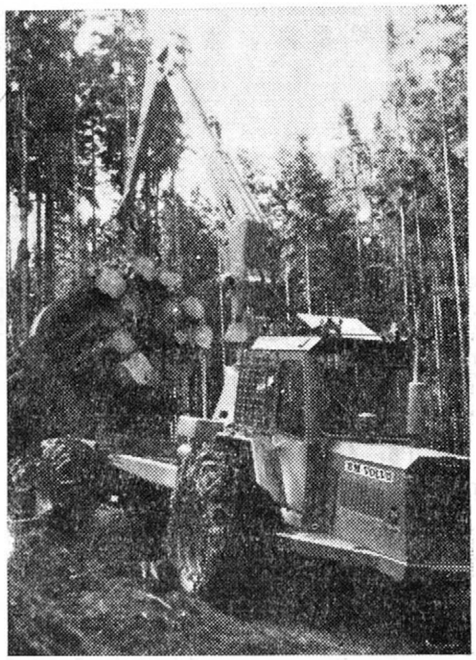
1b. Log skidding by hydraulic grapple mounted on special forest wheel tractor Kockum 861 (Logging technique no. 7). – Soustřeďování dřeva drapákovým závěsem na speciálním lesním kolovém traktoru Kockum 861 (technologie č. 7)

The logging techniques projections have been done in a way ensuring covering of all steps of the whole logging process, i. e. from the stump to railroad car, and/or sawmill yard, this being expressed in comparable figures and indices. Our calculations cover the whole logging process since the primary objective of this research is to arrive at the final effect, which is the ultimate, decisive goal, and which can be established by analysing the entire logging technique process only.

Being aware of the existence of different silvicultural systems and topographic conditions governing the nature of harvesting operations, we have based our investigations on the assumption that the major measure of practical applicability and feasibility of a logging system is the respective method of log skidding and extraction from forest stands.

On the basis of different skidding (extraction) distance, three logging technique classes have been distinguihed:

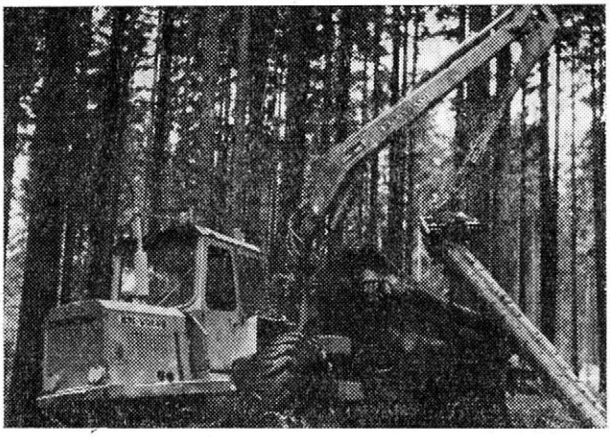
Under those forest regeneration systems in which felled timber is expected to be extracted from forest stands over distances greater than mean tree-length, log winching is likely to remain the major skilling method. It is thus necessary to continue studying the above methods, and to take care of their improvement along the lines determined by general ergonomic requirements. The above consideration applies to silvicultural systems and/or stand management policies employing shelterwood regeneration with subsequent log skidding, and to topographies excluding forest machinery because of their ruggedness.



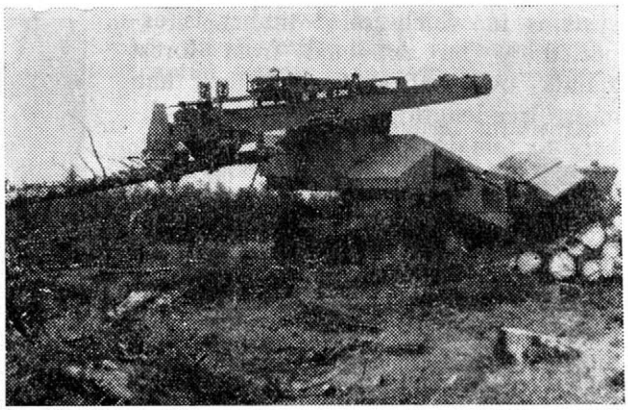
2. Log skidding by the skidding unit Volvo 868 with the bunk jaws (Technique no. 3). — Soustřeďování dřeva vyvážecí soupravou Volvo 868 se svěrným oplenem (technologie č. 3)

On the other hand, forest logging sites where machinery similar to tractors may operate, are open to the second class logging technique, featuring clear-cut reproduction and log skidding distances not exceeding average tree-length, i. e. within the reach of the hydraulic tongues (grapple).

In the third logging technique class belong the stand management systems based on shelterwood regeneration, yet admitting heavy equipment to forest stand interiors. In this case will the logging technique selection procedure aiming at their practical employment and economics assessment be done by way of relative comparisons of their respective characteristics which would fit best the parameters and limits applicable to a particular logging case for which an optimum logging technique is being looked for, of course in full consideration of the outlined objectives regarding productivity, labour safety, economics, etc.



3. Skidding of short-length timber by the tractor Volvo 868 under shelterwood cutting system (Techniques no. 5 and 6). — Soustřeďování krátkých sortimentů traktorem Volvo 868 v clonné seči (technologie č. 5 a 6)



4. Tree limbing by the Logma processor (Technique no. 7). — Odvětvování processorem Logma (technologie č. 7)

The following list of potential logging techniques is the outcome of our projections:

1. Standard logging technique based on special forestry tractor.
2. Logging technique based on hydraulic log skidders (loaders) (UT), Fig. 1.
3. Logging technique using the Volvo 868 log skidding unit and the bunk jaws (Fig. 2).
3a Dtto, with log skidding unit VKS-120 C.
4. Logging technique using the Volvo 868 skidding unit, and a front loader.
4a Dtto, with log skidding unit VKS-120 C.
5. Logging technique using an assortment unit (Fig. 3).
5a Dtto, with log skidding unit VKS-120.
6. Logging technique using an assortment unit, and a front loader on a forest log yard.
6a Dtto, with log skidding unit Z Crystal 8045.
7. Logging technique using a Logma processor, and a grapple mounted on a forest wheel tractor (Fig. 4).
8. Logging technique using a SM_2 limbing machine on the forest log yard.
8a Logging techniques using the SM_2 limbing machine on the forest log yard
8b Logging technique involving limbing of standing trees.
9. Logging technique using the ŐSA felling adaptor mounted on the Volvo

I. Summary of cost and man-hour requirement. — Rekapitulace nákladů a pracnosti

	Man-hours (cu. m.)				Cost (Kčs)			
	Optimum	Adjusted	Optimum	Adjusted	Optimum	Adjusted	Optimum	Adjusted
	Yard delivery		Railroad delivery		Yard delivery		Railroad delivery	
1.	0.91	0.93	1.00	1.02	48.40	49.69	54.00	55.29
2.	0.95	0.99	1.04	1.08	48.30	55.41	53.90	61.01
3.	0.97	0.97	0.97	0.97	67.08	67.08	67.08	67.08
3a	0.97	0.97	0.97	0.97	50.53	50.53	56.91	56.91
4.	0.96	1.02	0.96	1.02	62.11	69.00	62.11	69.00
4a	0.96	1.02	0.96	1.02	44.56	52.45	51.94	58.23
5.	0.87	0.87	0.98	0.98	63.45	63.45	69.83	69.45
5a	0.87	0.87	0.98	0.98	52.04	52.04	58.42	58.42
6.	0.87	0.96	0.98	1.07	58.48	67.95	64.86	74.33
6a	0.87	0.96	0.98	1.07	40.32	49.79	46.70	56.17
7.	0.56	0.59	0.67	0.70	69.32	73.05	74.92	78.65
8.	0.78	0.81	0.78	0.81	51.41	55.14	51.41	55.14
8a	0.74	0.77	0.74	0.77	64.18	67.91	64.18	67.91
8b	0.87	0.89	0.87	0.89	56.09	58.60	56.09	58.60
9.	0.62	0.65	0.62	0.65	62.30	66.03	63.30	66.03
9a	0.62	0.65	0.62	0.65	53.28	57.01	53.29	57.01
10.	0.67	0.68	0.67	0.68	69.92	70.62	69.92	70.62
11.	0.61	0.76	0.61	0.76	42.80	58.73	42.80	58.73

11. Logging technique based on the skidding unit Volvo 686 with bunk jaws. — Technologie s vyvážecí soupravou Volvo 868 a svěrným oplenem

Equipment purchasing price	Operation	Number of operators	Equipment specification	Equipment number for continuous operation	Percentage of total cut volume	Number of machine shifts for continuous operation	Productivity per shift (8.5 hr.) and worker	Operation cost (cu. m./Kčs)	Operation cost (cu. m./Kčs) for continuous operations and capacity indicated	Man-hours (hr./cu. m.)	Man-hours (hr./cu. m.) for continuous operation and capacity indicated	Productivity per shift and worker for all operations	Dtto — for continuous operation and capacity indicated	Logging technique characteristic
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Tree felling							4.00	4.00	0.10	0.10			
3500	Limbing	1	JMP saw	5	100	5.19	17.34	8.15	8.15	0.32	0.32			
	Bucking							2.03	2.03	0.07	0.07			
1,400.000	Log skidding	1	KBK	1	100	1.00	90.00	26.80	26.80	0.09	0.09			
400.000	Log loading and trucking	1	Log truck unit	1	100	1.20	75.00	15.46	15.46	0.11	0.11			
			Hydr. gr.											
350.000	Unloading		Frout l.	—	100	0.04	22.00	0.36	0.36	0.004	0.004			
3500	Bucking	3	JMP	1		0.60	50.00	3.90	3.90	0.17	0.17			
	Loading	2	Frout l.	1	100	0.60	75.00	6.38	6.38	0.11	0.11			
	Total		Timber yard					67.08	67.08	0.974	0.974	8.7	8.7	
			Railroad station (carriage)					67.08	67.08	0.974	0.974			

III. Logging technique parameters and feasibility limits. — Parametry a limity použitelnosti technologií

Topography classes				
No.	Parameter	Percentage		
1	Level ground, obstacle $V = <0.5$, dist. $= >5$	<25	25 –40	>40
2	Level ground, obstacle $V = <0.5$, dist. $= <5$	<25	25 –40	>40
3	Level ground, obstacle $V = >0.5$, dist. $= >5$	<25	25 –40	>40
4	Level ground, obstacle $V = >0.5$, dist. $= <5$	<25	25–40	>40
5	Continuous slope 100–300 m	>40	>40	>40
6	Continuous slope 300–600 m	>40	>40	>40
7	Continuous slope 600 m	>40	>40	>40
8	Antigravit. topography	<25	25–40	>40
9	Low-bearing-capacity ground	<25		
10	No-bearing-capacity ground	<25		
Silvicultural system parameters				
No.	Parameter	Cut area width to tree height ratio		
1	Shelterwood system	<1	1–2	>2
2	Strip-cutting system	<1	1–2	>2
3	Clear-cutting system	<1	1–2	>2
Logging parameters				
No.	Parameter	Range		
1	Tree species	conif.	broadl.	mixed
2	Mean tree volume	<1	<2	>2
3	Cut concentration (cu. m.)	<50	<200	>200
4	Timber concentration on amalgam. worksites	<50	<200	>200
5	Skidding distance (m)	<300	300– 600	>600
5a	Mean extraction distance (m)	0	grapple reach	cable
6	Log conversion place	forest stand	forest landing	lower landing
7	Time of equipment transfer	<1 km	1–3 km	>5 km
8	Lower landing area (ha)	0.2	0.5	1.0
9	Felling site assortment	graded timber	treelength	fulitree
Logging site preparation				
No.	Parameter	Specification		
1	Unloading for	Front loader	Hydraulic grapple	Mounted loader
2	Type of concentr. line	Current	Through	Access
3	Hauling road link	Through	Turning	Both

log skidding unit, SM_2 limbing machine, and front loader, on the forest log yard.

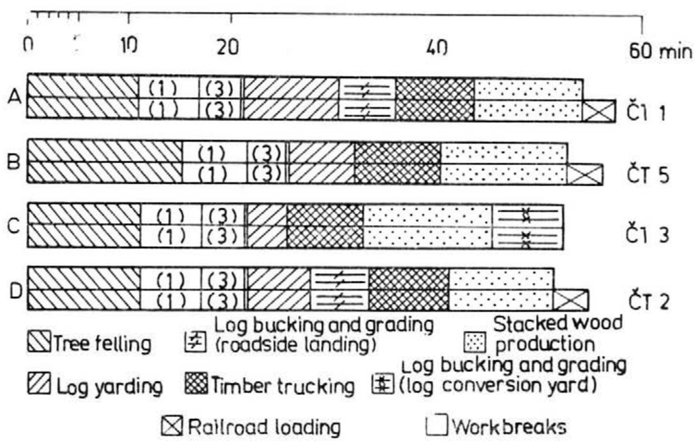
9a Dtto, with log skidding unit VKS-120.

10. Logging technique using the ŐSA felling adaptor, felling machine Bronemo, and a special forest tractor.

11. Logging technique using the VTM machine, SM_2 limbing machine, and front loader, and the forest log yard.

For the above-given logging techniques, the respective man-hour requirement and cost have been computed and tabulated (Table I).

For each particular logging technique, the respective man-hours (Fig. 5), cost, investment, necessary labour and material have been specified in detail. For information, such a breakdown for the logging technique employing the Volvo 868 skidding unit, and the bunk jaws is given below (Table II).



5. Man-hour requirement (cu. m.) graph for the logging techniques studied. — Graf pracnosti na 1 plm u ověřovaných technologií *A* — *D*

In addition to the man-hour requirement and cost calculation, also an evaluation method has been designed (including parameters and applicability limits) enabling feasibility appraisal of the respective logging techniques from the view-point of topography, stand conditions, logging conditions, and logging site preparation. To give an example, Table III presents the respective data on the logging technique mentioned above.

TESTING OF NEW LOGGING TECHNIQUES

Since some of the foreign equipment has been imported, it has been possible to field-test selected logging techniques (Table IV):

A. Standard logging technique using special forest tractor (ČT 1).

B. Logging technique based on the assortment unit (ČT 5), Fig. 3.

C. Logging technique employing the skidding unit and the bunk jaws (ČT 3), Fig. 2.

D. Logging technique using log-grapple skidding (UT) (ČT 2), Fig. 1.

The logging techniques under study were tested on the Bruntál, Albrechtice, and Janovice u Rýmařova State Forest Farms, where the average one-cut volume was some 300 cu. m., mean skidding distance ranging from 400 to 500 m, and mean hauling (trucking) distance 20 km, respectively. The tests were done

IV. Time required per 1 cu. m. (min) by logging technique. — Spotřeba času v h (min) na 1 plm v technologii *A—D*

Operation	*A*	*B*	*C*	*D*
Tree felling	0.35 (21.40)	0.42 (25.53)	0.35 (21.40)	0.35 (21.40)
Log skidding	0.16 (9.41)	0.11 (6.51)	0.07 (3.97)	0.10 (6.25)
Log bucking and conversion on forest log yard	0.10 (5.85)			0.10 (5.85)
Timber hauling	0.13 (7.58)	0.14 (8.30)	0.13 (7.53)	0.13 (7.58)
Stacked wood production	0.17 (10.20)	0.21 (12.60)	0.21 (12.60)	0.17 (10.20)
Log bucking on log conversion yard			0.12 (7.12)	
Railroad loading	0.06 (3.40)	0.06 (3.40)		0.06 (3.40)
Total; buyer s yard	0.91 (54.44)	0.88 (52.94)	0.87 (52.52)	0.85 (51.28)
Total; loco railroad	0.97 (57.84)	0.94 (56.34)	0.87 (52.52)	0.91 (54.68)

im mature coniferous stands where the mean tree volumes were 1.0 to 2.0 cu. m. (only exceptionaly below this figure), slope up to 20 per cent, and ground surface negotiable by special wheeled tractors.

CONCLUSIONS AND RECOMMENDATIONS

Our investigations have shown that in comparison with the standard logging technique, relatively highest saving would be achieved by using the logging technique based on log-grapple skidding UT (ČT 2), when timber is delivered by rail. In this case is the cost saving 8.63 Kčs/cu. m. When delivering the timber to the buyer's yard, the log-grapple skidding technique (ČT 2) was again found to be most economical, the respective cost-saving being 8.63 Kčs/ /cu. m. (Figs. 1a, 1b).

The existing standard logging technique based on the special forest tractor (ČT 1) has been highly perfectioned so that further cost savings are difficult to attain. Relative comparisons of different logging techniques have also revealed that a major cost-saving would be obtained from improved log skidding, while there was no visible progress as far as the cost-cut is concerned in the subsequent operations for the logging techniques compared so far, and as it appears it is likely do depend on the employment of multipurpose forest equipment.

From the view-point of productivity, in case of rail delivery most economical showed to be the logging technique using log skidding unit and bunk jaws (ČT 3) in which the man-hour saving was 0.1 hour/cu. m. (Fig. 2). In contrary, in case of customer's yard delivery, greatest time saving was obtained from log-grapple skidding (ČT 2), in which the man-hour input reduction was 0.06 hour/cu. m.

Similarly to economics, also the productivity improvement (man-hour savings) was best in the log skidding phase.

The other logging techniques investigated showed higher costs in comparison with the basic technique, and this may be explained in some cases by the fact that for the time being employment of expensive foreign-made imported equipment has been under consideration. Should these be manufactured in the country, the cost of operations would be reduced considerably.

It is interesting to note that all tested skidding techniques used no chokers (in contrast to the standard skidding technique (ČT 1) based on the logs being extracted from the stands by winch cables).

Important is the attained improvement in the working conditions, particularly in wintertime and in spring, when the tractor operator need not leave his cabin, and pave his way through deep snow, logging debris, and other obstacles. Also the very laborious choker setting would be no more necessary, particularly when working on muddy and waterlogged sites, wet snow, etc.

At the same time, the work safety and hygiene would improve, and the operators being not obliged to fight the often rugged forest sites, and consequently facing no broken cable and choker hazards, would be exposed to consi-

V. Theoretical Reduced Man-hour Input and Costs for the Logging Techniques

Tab. No.	Type of Equipment
1	JMP, LKT, OS 20 t + HR, ČN
2	JMP, UT + D, OS 20 t, ČN
3	JMP, KBK, OS 20 t + HR, ČN
3a	JMP, VKS – 120 C, OS 20 t + HR, ČN
4	JMP, KBK, OS 20 t, 2 ČN
4a	JMP, VKS – 120 C, OS 20 t, 2 ČN
5	JMP, Sort Volvo, OS 20 t + HR, ČN
5a	JMP, VKS – 120 S, OS 20 t + HR, ČN
6	JMP, Sort Volvo, OS 20 t + HR, 2 ČN
6a	JMP, Sort Crystal, OS 20 t + HR, 2 ČN
7	JMP, Logma, Kockum + D, OS 20 t, 2 ČN
8	JMP, LKT, SM – 2, OS 20 t, 2 ČN
8a	JMP, Bronemo, LKT, OS 20 t, 2 ČN
8b	O. S. S., JMP, LKT, OS 20 t + HR, ČN
9	KBK + KH, SM – 2, JMP, OS 20 t, 2 ČN
9a	VKS – 120 C, KH, SM – 2, JMP, OS 20 t, 2 ČN
10	KBK + KH, Bronemo, LKT, OS 20 t, 2 ČN
11	VTM – 4, SM – 2, JMP, OS 20 t, 2 ČN

Legend:

JMP – One-man chain saw
LKT – Forest wheel tractor LKT – 75 (ČSR)
OS 20 t – 20-ton log truck (Tatra 138, ČSSR)
HR – Hydraulic grab (e. g. Fiskars 6000, Finland)
ČN – Front loader
UT – Universal tractor
D – Grapple attachment
KBK – Log skidding unit with clamp stanchion (Volvo 868, Sweden)
VKS – 120 C – Log skidding unit with clamp stanchion (TEES, Martin, ČSSR)

derably lower accident risks. Furthermore, the physical load involved in the pulling of cables through forest stands is considerable (4 kcal/min), whereas the same figure for the from-the-cabin controlled operations are significantly lower.

On the other hand, the logging site preparation and management of the entire timber harvesting process have become much more demanding by the introduction of productive, sophisticated logging equipment and techniques.

The benefits drawn from the evaluation of new logging techniques applied to harvest cuttings are however not restricted to evidence on lesser man-hour requirement, reduced cost, improved work safety and hygiene, but there is a very important finding that the techniques in question are fully applicable also to smaller-scale logging operations, provided that several felling sites were amalgamated.

Studied. — Teoretická redukovaná pracnost a náklady u popsaných technologií

Man-hours (h/cu. m.)		Costs (Kčs/cu. m.)	
Delivery		Delivery	
Yard	Railroad Carriage	Yard	Railroad Carriage
0.93	1.02	49.69	55.29
0.99	1.08	55.41	61.01
0.97	0.97	67.08	67.09
0.97	0.97	50.53	56.91
1.02	1.02	69.00	69.00
1.02	1.02	52.45	58.23
0.87	0.98	63.45	69.45
0.87	0.98	52.04	58.42
0.96	1.07	67.95	74.33
0.96	1.07	49.79	56.17
0.59	0.70	73.05	78.65
0.81	0.81	55.14	55.14
0.77	0.77	67.91	67.91
0.89	0.89	58.60	58.60
0.65	0.65	66.03	66.03
0.65	0.65	57.01	57.01
0.68	0.68	70.62	70.62
0.76	0.76	58.73	58.73

Sort-Volvo — Assortment skidding unit (Volvo 868, Sweden)
VKS — 120 S — Assortment skidding unit (TEES, Martin, ČSSR)
Sort Crystal — Assortment skidding unit (Z Crystal 8045, ČSSR)
Logma — Limbing machine Logma (Sweden)
Kockum — Forest wheeled tractor Kockums 861 (Sweden)
SM — 2 — Limbing machine SM — 2 (ČSSR)
KH — Tree felling head (e. g. ÖSA — 640, Sweden)
VTM — 4 — Tree felling and skidding tractor (Soviet Union)
Bronemo — Limbing machine (Sweden)

It has been even found when evaluating the assortment unit (ČT 5) logging technology on the basis of several hundred cu. m. that the respective man-hour requirement would not increase even under intensive, small-scale silvicultural systems (Fig. 3).

SUMMARY

The paper deals with the designing of different logging systems and techniques for harvest cuttings in coniferous stands. The starting point of research is the standard logging technique based on special wheeled forestry tractor, and the respective research coverage was from tree felling to log shipping by railroad or direct truck-delivery to consumer's timber yard. A relative comparison was made of this standard technique with advanced methods employing up-to-date equipment listed in Tab. V.

So far, the following logging systems and techniques have been studied in Czechoslovakia:

A — Standard logging technique, using a special tractor (Logging technique No. 1)
B — Logging technique using the Sorti-Volvo 868 eqpipment (Logging technique No. 5)
C — Logging technique using the Sorti-Volvo 868 unit and the bunk jaws (Logging technique No. 3)
D — Logging technique using the universal tractor equipped with a grapple attachment (Logging technique No. 2)

The performance tests gave the corresponding man-hour inputs per cu. m. (tabulated in Tab. VI.)

VI. Man-hour Inputs per cu. m. for the Loggings Techniques Studied. — Pracnost na 1 plm u ověřovaných technologií

Operation	Man-hours (h/cu. m.) by Technique			
	A	*B*	*C*	*D*
Tree felling	0.35	0.42	0.35	0.35
Log yarding	0.16	0.11	0.07	0.10
Log bucking and grading (roadside landing)	0.10	—	—	0.10
Timber trucking	0.13	0.14	0.13	0.13
Stacked wood production	0.17	0.21	0.21	0.17
Log bucking and grading (log conversion yard)	—	—	0.12	—
Railroad loading	0.06	0.06	—	0.06
Total — customer's yard	0.91	0.88	0.87	0.85
Total — railroad carriage	0.97	0.94	0.87	0.91

The logging technique designs resulted also in the application feasibility characteristics taking into account the stand environmental and logging conditions prevailing in ČSR. The techniques studied have been found to be superior from the point of productivity, and some of them also from that of economy.

The results obtained do justify their recommendation for practical forestry application.

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Progresívní technologie v mýtních těžbách ČSR

Příspěvek řeší konstrukce různých technologických postupů v mýtních jehličnatých těžbách. Vychází ze standardní technologie, postavené na bázi speciálního kolového traktoru v rozsahu od mýcení až po vagón nebo sklad spotřebitele. Se standardní technologií jsou srovnávány progresívní technologie na bázi nových strojů, uvedených v tabulce V. Prozatím byly v podmínkách československého lesního hospodářství ověřovány technologie: A — Standardní technologie se speciálním traktorem (technologie č. 1). B — Technologie se sortimentovou soupravou Volvo 868 (technologie č. 5). C — Technologie s vyvážecí soupravou Volvo 868 a svěrným oplenem (technologie č. 3). — D — Technologie s univerzálním traktorem vybaveným drapákovým závěsem (technologie č. 2). Při ověření byla zjištěna pracnost na 1 plm uvedená v tabulce VI.

Konstrukce technologií zahrnují i parametry použitelnosti s ohledem na přírodně výrobní podmínky v lesním hospodářství ČSR. Ověřené technologie potvrdily předpokládaný efekt v produktivitě práce a některé i v hospodárnosti provozu. Výsledky opravňují k doporučení ověřených technologií do provozu.

Прогрессивная технология в главных рубках ЧСР

В статье рассматриваются конструкции разных технологических процессов в главных рубках хвойных. Исходным началом служит стандартная технология на базе специального колесного трактора в масштабе от вырубки вплоть до вагона или склада потребителя. Со стандартной технологией сравнивается прогрессивная технология на базе новых машин (табл. V, VI).

Progressive Technologien in Abtriebsnutzungen in der ČSR

In dem Beitrag wird die Konstruktion verschiedener technologischer Verfahren in den Nadelholzabtriebsnutzungen gelöst. Man geht von der Standardtechnologie, die im Bereich von der Nutzung bis zum Eisenbahnwagen oder Verbraucherlager auf die Basis des Spezialradtraktors gestellt wurde, aus. Mit der Standardtechnologie werden die progressiven Technologien auf der Basis der neuen Maschinen verglichen (Tab. V, VI).

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TREE SPACING AND DEVELOPMENT OF NORWAY SPRUCE STANDS

In recent years, there has been a continuing progress and technological development in forestry, and consequently also in the field of silviculture, and as a result of this the problem of optimum stocking density of future forest plantations and stands has come again to attention of forest research and practice. This is however not an entirely new problem since it had emerged in a similar context already by the end of the past century when the so called "closed stand" silviculture had been superseded by the so called "open stand" stand management methods. Typical in this respect is the so called millimetre-thinning designed by Josef B o h d a n e c k ý (1890) and used in some places in Bohemia; his method found both a wide response and had a considerable theoretical and practical impact which had been appreciated in a number of papers (e. g. V y s k o t 1969).

The above problem being very timely, a necessity arose to seek solutions to it even on the international level, and the subject has been taken up by a special working party of the International Union of Forestry Research Organizations (IUFRO 1969). It is obvious that the experimental plantations (forest stands) being established newly in line with the internationally accepted principles and procedures are of immense importance, yet that their results will not be available but after a number of years. Hence, the findings that could be drawn from the comparative experimental stands established by the end of the preceding century according to the practice adopted by the Mariabrunn Forest Research Institute should be utilized. It is only to regret that most of the above experimental plots have not been preserved to date, with a notable exception of the Norway Spruce comparative experimental stands set up in 1889 in the Forest District Lipůvka, former Brno Town Forest Farm. The plots were reconstructed by B. V i n c e n t in 1957, and recognizing the significance of the problem and long-term feature of the experiment on-going for not less than 84 years, we considered it appropriate to evaluate the experiment which is of importance from the present-day point of view.

DESCRIPTION OF THE EXPERIMENTAL STAND AND METHODS USED

This experimental stand intended for the study of the tree-to-tree distance and plant spacing on the plantation yield and economics, which was the wording of the Mariabrunn Research Institute research project objectives, was founded in 1889, its serial experiment number being 151. The respective tree species is Norway Spruce, the plot is located in the cadastral district Lipůvka u Brna, in the present stand No. 215b6. Its geographical co-ordinates are: 16°37-38′ east of Gr., 49°20-21′ n. l. The stand consists of three plots having an area of 0.4396 ha each, including the isolation strips. The experimetal plots proper are rectangles (62.5 by 40.0 m), their corresponding areas being 0.25 ha. In the spring of 1889, the plots and the isolation strips were planted to three-year-old transplants at three different spacings:

Plot I	—	spacing 1 by 1 m	—	4,396 plants
Plot II	—	spacing 1.5 by 1.5 m	—	1,954 plants
Plot III	—	spacing 2 by 2 m	—	1,099 plants

In the respective stand register, the afforestation cost and materials are precisely recorded, as well as detailed ways of plantation protection and tending in its early years of life.

ENVIRONMENTAL CONDITIONS

The experimental area is located in a region featuring mean annual temperature of 8 °C, and mean annual rainfall of 610 mm, respectively. The elevation a. s. l. ranges from 460 to 480 m; an eastern hillside has a slope of 11 to 17 °. The underlying rock contains amphibol and feldspar, the respective forest type being rich *Fagetum typicum asperuletosum.*

The experimental plots in question were surveyed in detail in 1972, and in 1973 thorough biometric field-measurements following our standard methods were made (V y s k o t 1969, 1966). The 1 by 1 m spacing plot was marked with red paint in the stand, the 1.5 by 1.5 m plot (II) with blue paint, and the 2 by 2 m plot (III) with green paint, respectively. In addition to the standard routine assessments, other research characters were recorded: tree leafing data, bark appearance, branchiness, and occurrence of the honey fungus. The objective of the latter was to judge the Norway Spruce ecotype, the species quality and health with regard to homogeneity of the experimental stands. Of major importance was the balance (total cut) of trees removed from the stands throughout the period of 84 years. The logging records prior to 1954 were available, and the subsequent data were reconstructed on the basis of stump survey, and results of forest inventories.

THE RESULTS OBTAINED AND THEIR EVALUATION

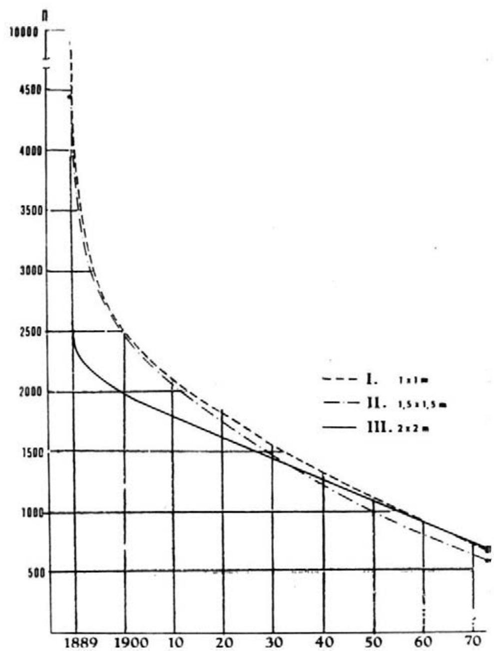
In 1973, full 84 years have passed since the establishment of the experimental plots under study by three-year plants, the respective age being then 87 years. Having made thorough mensurational and biometric measurements, we obtained a wealth of data the analysis of which (broken-down by individual characteristics) is given below.

TREE NUMBER

I. Tree number in 1956 and 1973. — Počet stromů v roce 1956 a 1973

Item	Plot I		Plot II		Plot III	
	plot	1 ha	plot	1 ha	plot	1 ha
	number					
Year 1956	247	988	218	872	245	980
Percentage of I	100		88.3		99.2	
Percentage of initial number	9.9		19.6		39.2	
Year 1973	171	684	146	584	175	700
Percentage of I	100		85.4		102.3	
Percentage of initial number	6.8		13.1		28.0	

The number of trees was judged on the basis of tree counts made in 1956 and 1973 (See Table I). In 1956, the plots I and III had virtually equal number of trees while the plot II was less tree-stocked. A similar situation prevailed also in 1973 when the number of trees on plot II was 15 per cent less. This fact does not result as an effect of the factors studied, but is obviously due to some other causes and circumstances that had occurred in the course of the long experiment period. It is however interesting, that the least-stocked (2 by 2 m spaced) plot the residual tree number was highest (Fig. 1).



1. Changes in tree number at different initial spacings, 1889 to 1973. — Vývoj počtu stromů při různém sponu 1889 až 1973.

BREAST HIGH DIAMETER

The breast high diameters in 1973 represent a difference of 24.2 cm for a 1 by 1 m spacing, a difference of 25.7 cm for the 1.5 by 1.5 m spacing, and 26.2 cm for the 2 by 2 m spacing, respectively. Statistical significance of the DBH arithmetic mean differences for individual plots was studied by means of Student's test, and it was found that its value for the I and II plots was 2.387, for the II and III plots 0.698, and eventually, for the plots I and III the t-test gave a value of 3.305. Statistically significant is the difference between the I and III plots, highly significant that between the I and III plots. As far as the degree of variation is concerned, it is lowest on plot I. The coefficient of skewness is positive on all plots, this indicating a left hand assymmetry compared to normal distributions, yet the differences between the plots are insignificant only (Tables II and III).

TREE HEIGHT

Mean tree height is lowest on plot I (25.8 m), tallest on plot II (28.0 m), the plot III being only slightly inferior to the latter (27.4 m). The significance of mean height differences among the plots was also tested, and the value of the t-test for plots I and II was found to be 7.575, that for plots II and III 2.043, and 5.691 for the I and III plots, respectively. The weight of the mean tree height on plot I is thus considerably less as far as its significance is concerned. The height differentiation, characterized by the standard deviation and by the coefficient of variation, is almost equal on all plots. Contrary to the breast high diameter, there is a right-hand skewness, maximum on plot II (Tables IV and V).

II. Breast high diameter distribution, 1973. —

Plot	Breast high diameter — cm						
	14	16	18	20	22	24	26
I	2	9	9	24	25	24	23
II	1	10	6	14	20	14	17
III	—	2	10	20	21	18	23

III. Statistical characteristics — breast high diameter, 1973. — Statistické údaje — výčetní tloušťky stromů, 1973

Characteristic	Plot		
	I	II	III
Arithmetic mean (cm)	24.20	25.69	26.15
Dispersion	24.161	33.261	31.172
Standard deviation (cm)	4.915	5.767	5.583
Coefficient of variation (%)	20.3	22.4	21.4
Average error of arithmetic mean (cm)	0.390	0.487	0.443
Coefficient of skewness	0.41	0.27	0.54
Coefficient of excess	0.03	−0.34	−0.27
Mode (cm)	22	—	—
Frequency	159	140	159

IV. Tree Height distribution, 1973. —

Plot	Height (m)						
	20	21	22	23	24	25	26
I	2	3	13	16	15	17	22
II	—	1	2	6	7	9	12
III	—	—	2	8	13	14	22

V. Statistical characteristics — tree heights, 1973. — Statistické údaje — výšky stromů, 1973

Characteristic	Plot		
	I	II	III
Arithmetic mean (m)	25.8	28.0	27.4
Dispersion	6.136	6.407	6.434
Standard deviation (m)	2.477	2.531	2.536
Coefficient of variation (%)	9.6	9.0	9.2
Average error of arithmetic mean (m)	0.196	0.214	0.201
Coefficient of skewness	−0.21	−0.50	−0.14
Coefficient of excess	−0.75	−0.37	−0.27
Mode (m)	27.2	29.0	29.0
Frequency	159	140	159

Rozložení výčetních tlouštěk v roce 1973.

Breast high diameter — cm								Total
28	30	32	34	36	38	40	42	
18	13	3	4	3	2	—	—	159
16	19	9	6	2	3	3	—	140
25	11	7	7	7	6	1	1	159

BASAL AREA

Total basal areas resulting from biometric measurements done in 1973 are almost equal on plots I and II, while that for the plot III is 17 per cent more. Mean per-tree basal area is largest with the widest spacing (2 by 2 m), smallest with the closest spacing (1 by 1 m). The medium-spaced plot shows a per-tree basal area approaching the wide spacing (Table VI).

DERBHOLZ VOLUME

The derbholz volume (Table VII, Fig. 2) was largest in 1956 on plot III, smallest on plot I, while the plot II was roughly in between. If we take as a standard the derbholz volume on the 1 by 1 m spaced plot (100 %), we find that at a stand age of 87 years the corresponding volume yield in terms of percentage was 113 per cent for 1.5 by 1.5 m spacing, and 124 per cent for 2 by 2 m spacing, respectively. The mean tree volume was largest on plot II (0.51

Rozložení výšek stromů, 1973.

Height (m)								Sa
27	28	29	30	31	32	33	34	
24	24	16	4	3	—	—	—	159
16	19	27	18	14	9	—	—	140
22	19	27	18	6	3	2	3	159

VI. Basal area, 1973. — Výčetní základny, 1973

Item		Plot		
		I	II	III
Basal area	(sq. m.)			
	per plot	7.615	7.623	8.929
	per ha	30.46	30.49	35.72
Mean basal area	(sq. m.)	478.9	544.5	561.6
Breast high diameter d_g (cm)		24.7	26.3	26.7

cu. m.), second was plot III (0.49 cu. mm.), and third placed plot I (0.40 cu. m.). All timber removals (tree cutting) accomplished prior to 1973 were largest on plot I, followed closely by plot II, and considerably lesser tree harvest was taken from plot III. The growing stock in 1973 provided a similar

VII. Derbholz volume, 1956 and 1973. — Zásoba hroubí, 1956 a 1973

Item	Plot I	Plot II	Plot III
	m³		
1956			
Volume per plot	97.76	110.28	121.01
Volume per ha	391.0	441.1	484.0
Volume percentage per plot (of I)	100	112.8	123.8
Mean tree volume	0.40	0.51	0.49
Tree logging before 1953 per plot	20.35	14.20	9.20
Tree logging before 1953 per ha	81.4	56.8	36.8
Reconstructed volume 1953—1973 per plot	34.70	39.81	35.70
Reconstructed volume 1953—1973 per ha	138.8	159.2	142.8
Total logging prior to 1973 per plot	55.05	54.01	44.90
Total logging prior to 1973 per ha	220.2	216.0	179.6
1973			
Volume per plot	105.30	109.67	130.74
Volume per ha	421.2	438.7	523.0
Volume percentage per plot (of I)	100	104.1	124.2
Mean tree volume	0.63	0.76	0.78
Total volume yield per plot	160.35	163.68	175.64
Total volume yield per ha	641.4	654.7	702.6
Total volume yield — (per cent of I)	100	102.4	110.0
Current periodic increment 1956—1973			
per plot	42.24	39.20	45.43
per ha	168.9	156.8	181.7
Mean annual increment			
per plot	2.48	2.31	2.67
per ha	9.9	9.2	10.7
per cent of I	100	92.8	107.6
per cent of 1956	2.54	2.09	2.21

VIII. Recorded f_i and theoretical f'_i tree frequencies by growth. — Pozorované f_i a teoretické f_i' četnosti stromů podle vzrůstu

Plot	*P*		*Ú*		*V*		*Z*		Total
	f_i	f_i'	f_i	f_i'	f_i	f_i'	f_i	f_i'	
I	33	34.4	96	94.4	24	22.2	6	8.0	159
II	24	30.2	94	83.2	12	19.6	10	7.0	140
III	42	34.4	82	94.4	28	22.2	7	8.0	159
Total	99		272		64		23		458

P — dominant, *Ú* — co-dominant, *V* — sub-dominant, *Z* — oppressed

IX. Tree volume distribution by growth classification. — Hmota stromů podle klasifikace vzrůstu

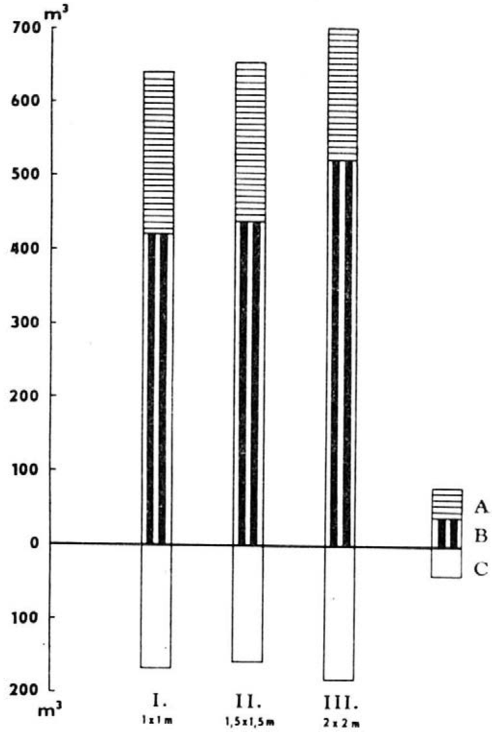
Plot	*P*		*Ú*		*V*		*Z*		Total	
	per plot	per ha	per plot	per ha	per plot	per ha	per plot	per ha	per plot	per ha
	m^3									
I	34.10	136.4	57.47	229.9	8.09	32.3	1.24	5.0	100.90	403.6
II	30.42	121.7	69.39	277.5	4.44	17.8	2.50	10.0	106.75	427.0
III	52.88	211.5	56.85	227.4	11.36	45.4	2.28	9.1	123.37	493.4
Total	117.40		183.71		23.89		6.02		331.02	

P — dominant, *Ú* — co-dominant, *V* — sub-dominant, *Z* — oppressed

X. Recorded f_i and theoretical f'_i value class frequencies. — Pozorované f_i a teoretické f_i' četnosti hodnotních tříd

Plot	Value class										Total
	I		II		III		IV		V		
	f_i	f_i'	f_i	f_i'	f_i	f_i'	f_i	f_i'	f_i	f_i'	
I	46	66.3	72	61.45	36	27.8	1	0.7	4	2.8	159
II	69	58.4	50	54.10	19	24.4	—	0.6	2	2.4	140
III	76	66.3	55	61.45	25	27.8	1	0.7	2	2.8	159
Total	191		177		80		2		8		458

2. Total volume yield at different spacings in 1973 (top), and current periodical increment 1956—1973 (bottom) per ha. Legend: *A* — tree logging prior to 1973, *B* — growing stock in 1973, *C* — increment from 1956 to 1973. — Celková hmotová produkce při různém sponu 1973 (nahoře) a běžný periodní přírůst 1956—1973 (dole) na 1 ha. Legenda: *A* — těžby do roku 1973, *B* — zásoba v roce 1973, *C* — přírůst v letech 1956 až 1973



picture: if we put that on plot I equal to 100 per cent, the growing stock on plot III represents 124 per cent, yet that on plot II only 104 per cent. The volume of the mean tree is maximum for a 2 by 2 m spacing (0.78 cu. m.), smallest for a 1 by 1 m spacing (0.63 cu. m.). Total derbholz volume yield per ha produced over 87 years is highest at a 2 by 2 m spacing (703 cu. m.), poorest at a 1 by 1 m spacing (641 cu. m.), the 1.5 m by 1.5 m spacing having yielded a total of 655 cu. m. It follows that the volume yield at a 2 by 2 m, spacing is 10 per cent more than that at a 1 by 1 m spacing. Current periodical increment for the years 1956 to 1973 was highest for a 2 by 2 m spacing, lowest for a 1.5 by 1.5 m spacing. The same is true of the mean annual increment, the difference of 8 per cent speaking for the Norway Spruce stand planted at a wide spacing.

XI. Tree volume by individual value classes. —

Plot	Value class					
	I		II		III	
	per plot	per ha	per plot	per ha	per plot	per ha
	m³					
I	42.20	168.8	37.55	150.2	17.89	71.5
II	70.71	282.8	27.09	108.4	8.16	32.7
III	80.61	322.4	29.41	117.6	11.62	46.5
Total	193.52		94.05		37.67	

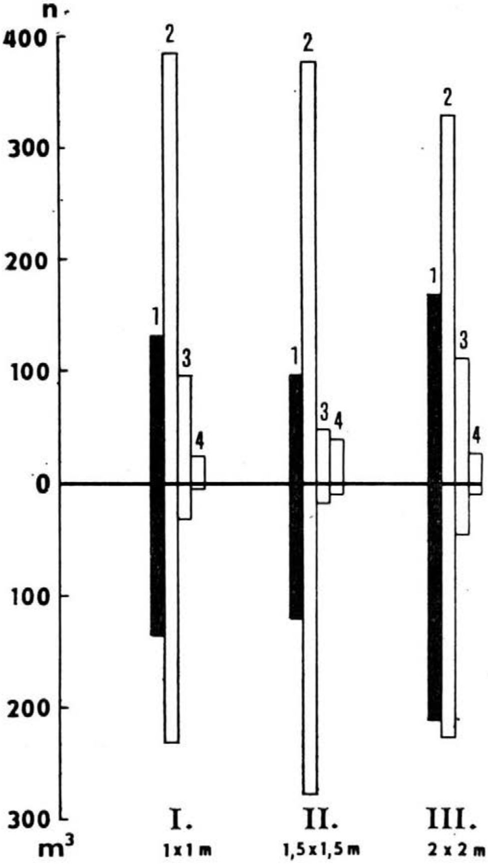
All trees of the stand under study were classified on the basis of growth as dominant (P), co-dominant (Ú), sub-dominant (V), and oppressed (Z). The respective impact of spacing distance was examined by a good fit test; for each spacing distance the corresponding theoretical frequencies and the χ-square value were computed (the latter as a sum of the recorded and theoretical frequency differences, divided by the sum of theoretical frequencies) (Table VIII). The value of the testing criterion was 12.586. It follows from the computation that the effect of spacing distance on the tree distribution by growth is of little significance (Fig. 3). The tree volumes in individual growth classes show that the largest proportion of dominant trees (by volume) is on the 2 by 2 m spaced plot; in case of the dominant trees, the 1.5 by 1.5 spaced plot placed first while the other two are on almost the same level. Largest volume of sub-dominant trees showed plot III, smallest plot II. The volume share of suppressed (overtopped, shaded) trees was insignificant on all plots (Table IX).

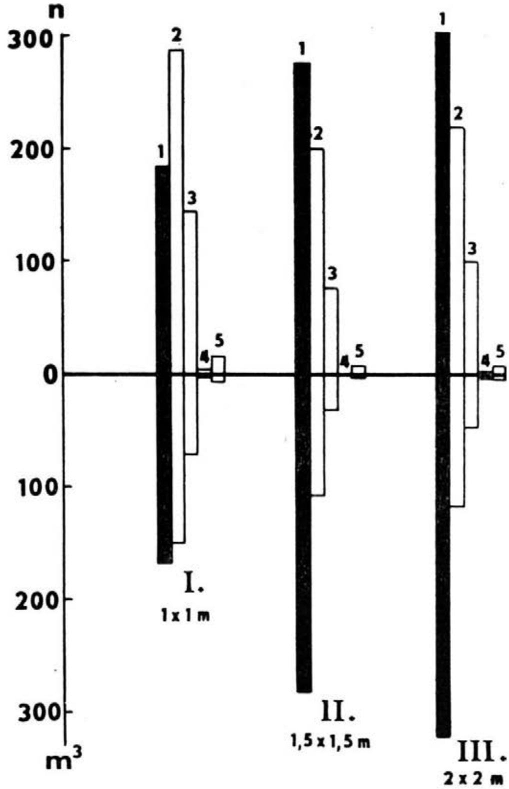
TREE QUALITY CLASSIFICATION

In order to judge the tree quality on the basis of tree dimensions and phenotype, we used our own classification (Vyskot 1949, 1966) employing the value indices and tree value classes. Medium value index was found to be best on plot II (5.55), and on plot III (5:63), worst on plot I (6.61). The actual (recorded) and theoretical value class frequencies were expressed, to verify the null-hypothesis, by means of the χ^2-test, the value of this testing criterion being 17.920. It follows from the relevant computations that the effect of tree spacing on the proportion of tree value classes is significant (Tables X and XI). Largest volume share of first-quality trees is on the plot with a 2 by 2 m spacing, the figure being 91 per cent more than for the 1 by 1 m spacing, and 68 per cent more than for the 1.5 by 1.5 m spacing. The tree quality classification has thus revealed that best tree population (sample) quality as judged on the basis of mensurational characteristics and tree habitus, is on the 2 by 2 m plot (Fig. 4).

Hmota stromů v jednotlivých hodnotních třídách

Value class				Total	
IV		V		per plot	per ha
per plot	per ha	per plot	per ha		
m³					
1.07	4.3	2.19	8.8	100.90	403.6
—	—	0.79	3.1	106.75	427.0
0.74	2.9	0.99	4.0	123.37	493.4
1.81		3.97		331.02	





3. Tree classification by growth: *1* — dominant trees, *2* — co-dominant trees, *3* — sub-dominant trees, *4* — oppressed (shaded) trees. Upper line: tree number, lower line: volume/ha. — Klasifikace stromů podle vzrůstu: *1* — předrůstavé, *2* — úrovňové, *3* — vrůstavé, *4* — zastíněné. Nahoře počet stromů, dole hmota na 1 ha.

4. Tree numbers (top) and volumes (bottom) by specified quality classes — per ha. — Počet stromů (nahoře) a hmota (dole) v jednotlivých třídách jakostní klasifikace na 1 ha

LEAFING TIME

With the purpose of identifying the proportion of individual Norway Spruce ecotypes on our experimental plots, we kept records of leafing dates for individual trees. Our observation showed that there is variation in the time of leafing, and that some of the trees are early-leafers (*praecox*), others late-leafers (*tardiflora*). Theoretical values were computed, and their fit the empirical data was examined by way of the t-test (χ^2) (Table XII). It is obvious from the results obtained that the largest number of early spruces are on the 1 by 1 m experimental plot, smallest on the 2×2 m one. The late-leafers are represented most on the 2 by 2 m spacing plot, the respective figure being almost twice that on the 1 by 1 m and 1.5 by 1.5 m spacing plots. This suggests ecotype differences that may too have a bearing on the other characteristics, particularly biometric ones.

TREE BARK

Another character studied was the bark of individual trees. For practical purposes, we distinguished only two categories of bark, smooth bark and rough one. The results (Table XIII) showed that the largest proportion of smooth-barked trees was on the experimental plot showing the absolutely widest spacing (2 by 2 m), and in contrast to this, Norway Spruce stands originated from 1 by 1 m spaced plantations had the largest representation of rough bark trees. A statistical analysis showed that the differences among the plots (spacing distances) in the number of smooth-barked and rough-barked trees were significant. Again, different ecotype pattern obviously manifests itself.

XII. Tree leafing. — Rašení stromů

Plot	Number of leafing trees				
	praecox		*tardiflora*		total
	f_i	f_i'	f_i	f_i'	
	number				
I	119	103.8	40	55.2	159
II	99	91.4	41	48.6	140
III	81	103.8	78	55.2	159
Total	299		159		458

XIII. Tree bark. — Kůra stromů

Plot	Number of trees by bark type				
	smooth		rough		total
	f_i	f_i'	f_i	f_i'	
	number				
I	72	77.4	87	81.6	159
II	59	68.2	81	71.8	140
III	92	77.4	67	81.6	159
Total	223		235		458

TREE BRANCHINESS

The tree quality depends to a large degree on the number and diameter of branches, and this is why we assigned the standing stock to two broad classes: thin-branched trees, and thick-branched ones. The number of thick-branched trees was found to be small in all the three cases, making up about one quarter of the total. Thin-branched trees were present in virtually equal number both on the 1 by 1 m and 2 by 2 m spacing plots (Table XIV), this demonstrating that the wide spacing (2 by 2 m) had no effect whatsoever on undesirable tree branchiness, having thus no bearing in this respect on tree quality.

XIV. Tree branchiness. — Větevnatost stromů

Plot	Number of trees by branch type				
	thin		thick		total
	f_i	f_i'	f_i	f_i'	
	number				
I	128	127.05	31	31.95	159
II	113	111.90	27	28.10	140
III	125	127.05	34	31.95	159
Total	366		92		458

XV. Trees affected by honey fungus. — Stromy napadené václavkou

Plot	Tree number				
	affected		unaffected		total
	f_i	f_i'	f_i	f_i'	
	number				
I	32	36.1	127	122.9	159
II	28	31.8	112	108.2	140
III	44	36.1	115	122.9	159
Total	104		354		458

XVI. Crown projection area and crown canopy. — Plocha korun a zápoj

Plot	Crown area		Canopy
	per plot	per ha	
	sq. m.		
I	1865.27	7461.1	0.75
II	1692.47	6769.9	0.68
III	1745.82	6983.3	0.70

It is a well known fact that the tree health and soundness represent a limiting factor governing survival and yield of forest stands. This is true particularly of the Norway Spruce in drier regions, which is also in our case. Having the above in mind, we studied the health condition of individual trees and found many of them attacked by the honey fungus (*Armillariella* Karst.). It follows from the tabulated data (Table XV) that the number of the honey fungus infest trees ranges from one fourth to one third of the tree population on the respective experimental plot. Relatively greatest number of infested trees was found on the 2 by 2 m spacing plot, lowest on the 1 by 1 m one. In a statistical evaluation the magnitude of the testing criterion (χ^2) was found to be 3.427, and the number of the degree of freedom was 2. Critical χ^2 value for 2 degrees of freedom and a 5 per cent significance level is 5.99, for a 1 per cent significance level 9.21, respectively. The above analysis provided evidence that the differences in the number of honey fungus affected trees among the plots studied are of random nature only.

SITE CLASS AND STOCKING DENSITY

The site class mean (Schwappach) for the given age and mean tree height on specified experimental plots is I/II. The per hectare basal area is 30.46 sq. m. (spacing 1 by 1 m), 30.49 sq. m. (spacing 1.5 by 1.5 m), and 35.72 sq. m. (spacing 2 by 2 m), respectively. The respective stocking densities are as follows: 0.7 (1 by 1 m), 0.7 (1.5 by 1.5 m), and 0.8 (2 by 2 m).

CROWN CLOSURE

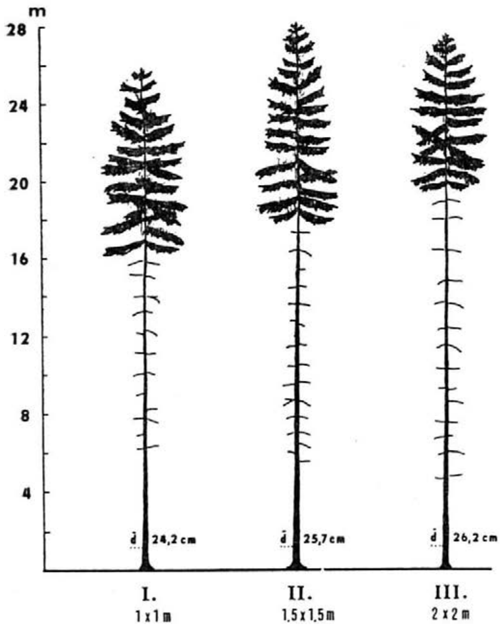
The crown closure was expressed as a ratio of the tree crown vertical projections and experimental plot area (Table XVI). By far the largest tree crown projection area (7.461 sq. m./ha) was found on the 1 by 1 m spacing plot, second placed the 2 by 2 m spacing plot with 6.983 sq. m., and least crown projection area was that on the 1.5 by 1.5 m spacing plot, namely 6.770 sq. m. This is also in agreement with the biological canopy — 0.75, 0.70, and 0.68, respectively.

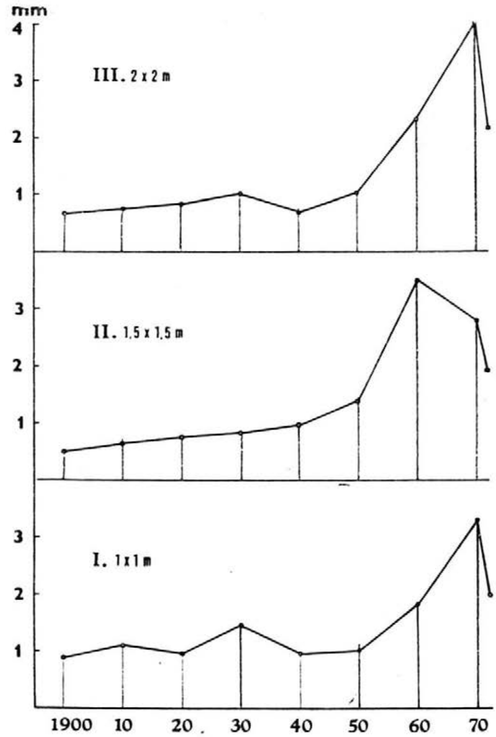
TREE BOLE AND TREE CROWN

When doing a comprehensive tree or stand assessment, it is important to compare the data describing the dimensions of the tree crown and tree bole. For this reason the data on crown width, crown length, average length of branch--free bole, and average bole length (Table XVII, Fig. 5) were included, and it follows from them that widest mean crown width (3.92 m) was found on the 1.5 by 1.5 m spacing plot, narrowest (3.50 m) on the 2 by 2 m spacing plot. This is an interesting fact since the volume yield on the 2 by 2 m plot is largest. The 1.5 by 1.5 m spacing resulted in longest crowns, shortest ones were on the plot initiated at a 2 by 2 m spacing. Again, this shows that smallest mean crown was on the 2 by 2 m spacing plot, and as it appeared from the foregoing, this spacing alternative features the largest proportion of dominant trees characterized by highest yields and growing stocks. Longest branch-free boles were found to be associated with the 1.5 by 1.5 m plot (6.25 m), shortest on the 2 by 2 m spacing plot (4.61 m).

XVII. Tree bole and crown. — Kmen a koruna

Characteristic	Plot I (m)	Plot II (m)	Plot III (m)
Mean crown width	3.87	3.92	3.50
Mean crown length	9.65	10.15	7.87
Mean length of branch-tree bole	6.25	5.62	4.61
Mean bole length	16.15	17.81	19.54





5. Habitus and mensurational characteristics of mean trees grown at different initial spacings. — Habitus a biometrické veličiny průměrných stromů vypěstovaných v různém sponu
6. Year-ring analysis of mean sample trees, 1900 to 1973. — Analýza letokruhů průměrných vzorníků, 1900—1973

TREE CARRYING AREA AND TREE SPACING INDEX

The tree carrying area is largest on the 1.5 by 1.5 m spacing plot (17.86 sq. m.), while the two other plots are equal in this respect (15.72 sq. m.). The tree spacing index is 4.25 m for the 1.5 by 1.5 m plot, 3.97 m for the 1 by 1 m and 2 by 2 m plots, respectively (Table XVIII).

XVIII. Carrying area and spacing index. – Úživná plocha a rozestupové číslo

Item	Plot		
	I	II	III
Carrying area (sq. m.)	15.723	17.857	15.723
Spacing index (m)	3.965	4.226	3.965

YEAR-RING ANALYSIS

The quantitative data studied or compared in the foregoing were of biometric or phenotypic nature; in order to define the wood qualities of the Spruce populations under study, and in order to learn about the laws governing the year-ring and year-ring width formation, we selected 36 sample trees to be analysed (at DBH height) on a tree analyser operated by the Department of Silviculture, Brno (V y s k o t 1972). The results of our analyses (Fig. 6) pertaining to the years 1900 to 1973 reveal that an average sample tree taken in 1973 exhibits largest initial year-ring width increment (at breast height) on the 1 by 1 m spacing plot, the 1.5 by 1.5 m plot being worst as far as diameter increment is concerned. Absolute year-ring width maximum was attained in 1970 by the 2 by 2 m spacing plot; this record performance cannot be however due to the initial plantation spacing. We can thus hardly say that in our particular case the initial tree spacing had a general distinct bearing on the diameter (year-ring) growth in average sample trees. A conclusive judgment can not be passed until upon termination of the experiment, i. e. at the stand age of at least 100 years when all of them are available to analysis. For the time being, to conserve the experimental stand under study we only took some representative sample borings while the cross-sections for the year-ring analysis were taken from the drought-killed trees. Fort this reason should not the data presented be regarded as conclusive ones.

CONCLUSIONS

Continuing technological development and improvement in forestry and silviculture have made it necessary to search for optimum stocking density of forest plantations. This problem arose in a similar context already at the end of the previous century, and gave rise to the so called Czech millimetre thinning. On the international level, the subject has been studied particularly in relation to Norway Spruce, yet the experiments under way are of a long-term nature so that their results are likely to be available but after a number of years. For this reason the retrospective methods are to be employed, and the experimental stands established in the past are to be evaluated. One of them, set up in line with the practices of the former Mariabrunn Forest Research Institute near Wien, is an experimental spacing trial located in the Forest District Lipůvka, Brno area. The plot was planted in the spring of 1889 with three-year-old Norway Spruce transplants; it consists of three comparative plots, 0.25 ha each. The initial spacings of the plots I, II, and III were 1 by 1 m, 1.5 by 1.5 m, and 2 by 2 m, respectively. The experiment is located in the stand No. 215 b_6, the geographical co-ordinates being 16^0 37—38′ e. l., and 49^0 20—21′ n. l., elevation above sea level 460 to 480 m, mean annual temperature 8 °C, mean annual rainfall 610 mm. The slope of an eastern hillside is 11 to 17°, the underlying rock containing amphibolite and feldspar. The stand belongs, from the point of forest typology, to *Fagetum typicum asperuletosum.*

Our measurements were done in 1973, when the stand was 87 years of age. The residual tree number was greatest on the plot spaced initially 2 by 2 m, while that on the 1.5 by 1.5 m plot was 15 per cent less. The breast high diameter was greatest for a 2 by 2 m spacing, smallest for a 1 by 1 m spacing distance. Mean tree height in 1973 was minimum at a 1 by 1 m spacing, maximum at a 1.5 by 1.5 m spacing, that for the 2 by 2 m spacing being only slightly different from it. The stand basal area for the 2 by 2 m spacing plot is 17 per cent more than that for other plots, and the derbholz volume in terms of percentage is 124 per cent for the 2 by 2 m plot, and 104 per cent for the 1.5 by 1.5 m plot (in relation to the 1 by 1 m plot taken as a standard). The value of the mean tree is highest at a 2 by 2 m spacing, lowest at a 1 by 1 m spacing. Total volume yield in the course of 87 years for the 2 by 2 m spacing was 10 per cent more than for the 1 by 1 m initial spacing. Mean annual increment on the wide spacing plot is 8 per cent more than on the close spacing one. Our classification of trees on the basis of growth showed that on the wide--spaced plot the percentage of dominant trees is highest as well as their growing stock share. A quality classification revealed that best tree qualities from the point of biometric and phenotypic characteristics were attained by the 1.5 by 1.5 m and 2 by 2 m spaced stands, the 1 by 1 m spaced one being inferior to them. Best qualities for individual tree classes were attained with a 2 by 2 m initial spacing. The judgment of ecotype proportion was made on the basis of leafing time, bark character, and branchiness observations. The plot with the best yield performance (2 by 2 m) showed almost 50 per cent of the late leafers (*tardiflora*) while the closest-spaced plot (1 by 1 m) exhibited two thirds of the early-leafing (*praecox*) trees. In the above respect, the 1.5 by 1.5 m plot was similar to the 1 by 1 m spacing one. Highest percentage of trees with smooth bark was found on the 2 by 2 m spacing plot, lowest on the 1.5 by 1.5 m one. This points to a certain difference of ecotypes within the population studied. The wide spacing (2 by 2 m) exhibited an absolutely largest proportion of thin-branched trees, the respective figures for the other plots being only slightly different. This indicates that in the case under study tree branchiness had not been governed significantly by initial tree spacing. The Norway Spruce trees of the experimental stands were found to be infected partly by the honey fungus (*Armillariella* Karst.), and our investigations showed that the existing differences in the number of fungus-affected trees on the plots are of random nature only. Largest crown projection area was found on the 1 by 1 m plot, smallest on the 1.5 by 1.5 m one; widest mean crowns at the age of 87 years as well as longest crowns showed the 1.5 by 1.5 m spacing plot. Longest mean boles were recorded on the 2 by 2 m plot, longest limb-free bole portion on the 1.5 by 1.5 m one. The carrying area was largest on the 1.5 by 1.5 m spacing plot, and the same was true of the spacing index.

A comprehensive evaluation of this 87-year spacing experiment (1 by 1 m, 1.5 by 1.5 m, 2 by 2 m) on Norway Spruce in a drier region leads to a conclusion that initial plant spacing of 2 by 2 m, i. e. 2,500 strong transplants to the hectare, showed the best results virtually in every respect. From this, a conclusion may be drawn that silvicultural improvements in the field of establishment and tending of Norway Spruce stands by way of wide initial spacing is both feasible and economical.

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Spon a vývoj smrkového porostu

Racionalizace v lesním hospodářství a v pěstění lesů vyžaduje řešení vhodné hustoty v zakládaných lesních porostech. Tento problém se objevil v obdobných souvislostech již koncem minulého století a dal vznik tzv. české milimetrové probírce. V mezinárodním měřítku se zkoumá tato otázka především u smrku. Pokusy však mají dlouhodobý charakter, takže výsledky budou k dispozici až za mnoho let. Proto je třeba využívat retrospektivní metody a zhodnotit v minulosti založené pokusné plochy. Jednou z takových ploch založenou podle metodiky bývalého Výzkumného lesnického ústavu v Mariabrunnu u Vídně je výzk. plocha v polesí Lipůvka u Brna. Na tuto plochu byly na jaře roku 1889 vysázeny tříleté školkované sazenice smrku. Skládá se ze tří srovnávacích dílců, každý o rozměru 0,25 ha. Dílec I byl založen ve sponu 1 $\times$ 1 m, dílec II ve sponu 1,5 $\times$ 1,5 m a dílec III ve sponu 2 $\times$ 2 m. Plocha je v porostu 215b6, zeměpisné souřadnice jsou 16°37-38′ v. d. a 49°20-21′ s. š. Nadmořská výška je 460-480 m, průměrná roční teplota činí 8 °C, průměrné srážky 610 mm. Terén má sklon 11-17°, východní svah, geologický podklad tvoří amfibol a živec. Skupina lesních typů — bohatá bučina mařinková.

Naše měření bylo konáno v roce 1973, kdy věk porostu byl 87letý. Konečný počet stromů je největší na ploše se sponem 2 × 2 m. Na ploše se sponem 1,5 × × 1,5 m je o 15 % menší. Výčetní tloušťka je největší při sponu 2 × 2 m, nejmenší při sponu 1 × 1 m. Střední porostní výška byla v roce 1973 nejnižší u sponu 1 × 1 m a nejvyšší u sponu 1,5 × 1,5 m, od níž se jen málo liší výška při sponu 2 × 2 m. Celková výčetní základna je na sponu 2 × 2 m o 17 % větší než u ostatních dílců. Zásoba hroubí při sponu 2 × 2 m činí 124 % a u sponu 1,5 × 1,5 m 104 % hodnoty na dílci se sponem 1 × 1 m. Hodnota středního kmene je největší při sponu 2 × 2 m a nejmenší při sponu 1 × 1 m. Celková hmotová produkce za 87 let je při sponu 2 × 2 m o 10 % vyšší než u sponu 1 × 1 m. Průměrný roční přírůst je o 8 % větší při řídkém sponu než při hustém sponu. Klasifikace stromů podle vzrůstu ukázala, že v řídkém sponu je největší podíl předrůstavých stromů s největší zásobou. Jakostní klasifikace ukazuje, že nejvyšší kvality stromů podle biometrických a fenotypických znaků dosahuje porost ve sponu 1,5 × 1,5 m a 2 × × 2 m a nejhorší ve sponu 1 × 1 m. Nejlepší jakost v jednotlivých třídách byla dosažena při sponu 2 × 2 m. Pro posouzení ekotypů bylo hodnoceno také rašení stromů, jemnost kůry a větevnatost. Produkčně nejlepší dílec se sponem 2 × 2 m měl skoro polovinu stromů pozdně rašících (*f. tardiflora*), zatímco nejhustší dílec se sponem 1 × 1 m měl dvě třetiny stromů časně rašících (*f. praecox*). Při sponu 1,5 × 1,5 m je stav obdobný jako při sponu 1 × 1 m. Největší procento stromů s hladkou kůrou bylo zjištěno na dílci s řídkým sponem 2 × 2 m a nejmenší ve sponu 1,5 × 1,5 m. Naznačuje to jistou rozdílnost ekotypů v rámci zkoumané populace. Největší podíl jemně zavětvených stromů má řídký spon 2 × 2 m, od něho se jen málo liší ostatní spony. Znamená to, že v daném případě větevnatost stromů nebyla sponem výrazně ovlivněna. Zjistili jsme, že smrky na výzkumných plochách jsou částečně napadeny václavkou (*Armillariella* Karst.). Šetření ukázalo, že rozdíly v počtu napadených stromů jsou na plochách s různým sponem pouze náhodné. Největší výčetní základnu má nejřidší plocha se sponem 2 × 2 m, ostatní se od ní liší jen velmi málo. Největší plochu korun má plocha se sponem 1 × 1 m a nejmenší 1,5 × 1,5 m. Průměrnou šířku koruny v 87 letech má největší plocha ve sponu 1,5 × 1,5 m a rovněž délku koruny. Největší průměrnou délku kmene má dílec ve sponu 2 × 2 m a nejdelší vyčištěnou část kmene spon 1,5 × 1,5 m. Úživná plocha je největší na sponu 1,5 × 1,5 m, taktéž i rozestupové číslo.

Zhodnotíme-li celkově 87letý výzkum se sponem 1 × 1 m, 1,5 × 1,5 m a 2 × × 2 m ve smrkovém porostu sušší oblasti, můžeme konstatovat, že spon 2 × 2 m, tj. 2500 silných sazenic na 1 ha, vykazuje prakticky ve všech ukazatelích nejlepší výsledky. Z toho lze odvodit, že racionalizace zakládání a výchovy smrkových porostů v řidším sponu je možná a účelná.

Расстояние между деревьями и развитие елового лесонасаждения

Рационализация лесного хозяйства и лесоводства требует установления подходящей густоты закладываемых лесонасаждений. Эта проблема появилась в подобных аспектах уже в конце прошлого века и стала причиной возникновения так наз. чешского миллимерового прореживания. В международном масштабе этот вопрос изучается, главным образом, у ели. Однако опыты носят долгосрочный характер, и результаты поступят через много лет. Поэтому надо использовать ретроспективный метод и оценивать заложенные в прошлом опытные площади. Одна из них, заложенная по методике бывшего НИИ лесоводства в Мариабрунне под Веной, — это опытная площадь в лесничестве Липувка под Брно. На площади высадили 3-летние питомниковые саженцы ели — весной 1889 г. Площадь состоит из 3 сравнительных делянок по 0,25 га каждая. Делянка I заложена со схемой посадки 1 × 1 м, делянка II — 1,5 × 1,5 м, делянка III — 2 × 2 м. Площадь насаждения 215бб, геогр. координаты 16°37—38′ в. дл. и 49°20—21′ с. ш. Высота н. у. м. 460—480 м, среднегодовая температура 8 °C, среднегодовые осадки 610 мм. Наклон рельефа 11—17°, восточный склон, геологическое основание образуют амфибол и полевой шпат. Группа лесотипов — богатый буковый ясменниковый лес.

Мы провели измерения в 1973 г., возраст насаждений был 87 лет. Финальное количество деревьев самое высокое на площади со схемой 2 × 2 м, а на площади 1,5 × 1,5 м — на 15 % меньше. Диаметр на высоте груди наибольший при схеме 2 × 2 м, а наименьший при схеме 1 × 1 м. Средняя высота насаждения в 1973 г. была самая малая при схеме 1 × 1 м и самая большая при схеме 1,5—1,5 м, от которой мало отличается высота при схеме 2 × 2 м. Общая сумма площадей сечения при схеме 2 × 2 м на 17 % больше, чем на остальных делянках. Запас крупной древесины при схеме 2 × 2 составляет 124 %, и при 1,5 × 1,5 м — 104 % величины на делянке 1 × 1 м. Величина среднего ствола наибольшая при схеме 2 × 2 м и наименьшая при схеме 1 × 1 м. Общая производительность массы за 87 лет при схеме 2 X 2 м на 10 % больше, чем при 1 X 1 м. Среднегодовой прирост на 8 % больше при более редкой схеме. Классификация деревьев на основе роста показывает, что при редкой схеме имеется самое большое количество господствующих деревьев с наибольшим запасом. Классификация качества показывает, что наибольшего качества деревьев по биометрическим и фенотипическим признакам насаждение достигает при схеме посадки 1,5 X 1,5 м и при 2 X 2 м, а самого низкого — при 1 X 1 м. Лучшего качества по отдельным классам достигнуто при 2 X 2 м. Для оценки экотипов учитывали также распускание деревьев, тонкость коры и ветвистость. В отношении продукции лучшая делянка со схемой 2 X 2 м была почти наполовину поросшая поздно распускающимися деревьями, а делянка 1 X 1 м — рано распускающимися. При схеме 1,5 X 1,5 м состояние подобно, как и при 1 X 1 м. Наибольший % деревьев с гладкой корой установлен на делянке с редкой схемой (2 X 2 м), а наименьший — с 1,5—1,5 м. Это свидетельствует об определенном различии экотипов в рамках изучаемой популяции. Наибольшая доля деревьев с тонкой ветвистостью находится при схеме 2 X 2 м, остальные мало отличаются. Следовательно, в данном случае ветвистость деревьев не обусловливается в большой мере схемой посадки. Мы установили, что ель на опытных площадях частично поражена опенком (**Армиллариелла** Карст.). Обследование показало, что различия в количестве пораженных деревьев на площадях с разной схемой лишь случайные. Перечетная база самая крупная на самой редкой площади (2 X 2 м), остальные отличаются от нее незначительно. Наибольшая площадь кроны находится на площади со схемой 1 X 1 м, а наименьшая — на площадях со схемами 1,5 X 1,5 м. Средняя ширина крон у 87-летних деревьев наблюдается на схеме 1,5 X 1,5 м, где и наибольшая длина. Наибольшая средняя длина ствола наблюдается при схеме 2 X 2 м, а самая длинная вычищенная часть ствола — при 1,5 X 1,5 м. Полезная площадь самая крупная при 1,5 X 1,5 м, как и число расстояний.

Общая оценка 87-летних посадок со схемой 1 X 1 м, 1,5 X 1,5 м и 2 X 2 м еловых насаждений в засушливой области показывает, что схема посадки 2 X 2 м, т. е. 2500 толстых саженцев на га по всем показателям дает лучшие результаты. Из этого можно судить, что рационализация закладки и ухода еловых насаждений при более редкой схеме возможна и целесообразна.

Verband und Entwicklung eines Fichtenbestandes

Für die Rationalisierung in der Forstwirtschaft und in dem Waldbau ist die Lösung einer zweckmäßigen Dichte in den anzulegenden Waldbeständen erforderlich. Dieses Problem kam bereits am Ende der vergangenen Jahrhunderts in ähnlichen Zusammenhängen zum Vorschein und verursachte das Entstehen der sogenannten tschechischen Millimeterdurchforstung. In einem internationalen Maßstab wird diese Frage vor allem bei der Fichte untersucht. Die Versuche sind jedoch von einem langdauernden Charakter, sodaß die Ergebnisse erst nach vielen Jahren zur Verfügung sein werden. Es ist daher erforderlich, die restrospektive Methode einzusetzen und die früher in der Vergangenheit angelegten Versuchsflächen zu bewerten. Eine solcher, nach der Methodik des ehemaligen Forschungsinstituts für Forstwirtschaft in Marianbrunn bei Wien angelegten Flächen ist die Forschungsfläche in dem Forstrevier Lipůvka bei Brno. Diese Fläche wurde im Frühjahr 1889 mit dreijährigen verschulten Fichtenpflanzen angelegt. Sie besteht aus drei Vergleichsunterabteilungen, jede von einem Ausmaß von 0,25 ha. Die Unterabteilung I wurde in einem Verband 1 X 1 m, die Unterabteilung II in einem Verband 1,5 X 1,5 m und die Unterabteilung III in einem Verband 2 X 2 m angelegt. Die Fläche befindet sich im Bestand 215b6, die geographischen Koordinaten sind 16°37-38′ östlicher Länge und 49°20-21′ nördlicher Breite. Seehöhe ist 460-480 m, die durchschnittliche Jahrestemperatur beträgt 8° C, die durchschnittlichen Niederschläge sind 610 mm. Das Gelände hat eine Neigung von 11-17°, östlicher Hang, die geologische Unterlage besteht aus Amphibol und Feldspat. Waldtypengruppe — reicher Waldmeister-Buchenwald.

Unsere Messungen erfolgten im J. 1973, als der Bestand 87 Jahre alt war. Die höchste Endzahl der Bäume befindet sich auf der Fläche mit dem Verband 2 X 2 m. Auf der Fläche 1,5 X 1,5 m ist diese um 15 % niedriger. Der höchste Brusthöherdurchmesser ist bei dem Verband 2 X 2 m und der niedrigste bei dem Verband 1 X 1 m. Die mittlere Bestandeshöhe im J. 1973 ist die geringste bei dem Verband 1 X 1 m und die größte bei dem Verband 1,5 X 1,5 m, von den sich die Höhe bei dem Verband 2 X m nur wenig unterscheidet. Die gesamte Bestandsgrundfläche ist bei dem Verband 2 X 2 m um 17 % größer als bei den anderen Unterabteilungen. Der Derbholzvorrat beträgt bei dem Verband 2 X 2 m 124 % und bei dem Verband 1,5 X 1,5 m 104 % des Wertes auf der Unterabteilung

1 × 1 m. Der Mittelstammwert ist der größte bei dem Verband 2 × 2 m und der geringste bei dem Verband 1 × 1 m. Die Gesamtmassenleistung für 87 Jahre ist bei dem Verband 2 × 2 m um 10 % höher als bei dem Verband 1 × 1 m. Der durchschnittliche Jahreszuwachs ist bei einem breiten Verband um 8 % höher als bei dem engen Verband. Die Baumklassifizierung nach Wuchs zeigte, daß in dem breiten Verband der größte Anteil an herrschenden Bäumen mit dem größten Vorrat ist. Die Qualitätsklassifizierung zeigt, daß die höchsten Baumqualitäten nach den biometrischen und Phänotypmerkmalen durch den Bestand in dem Verband 1,5 × 1,5 m und 2 × 2 m, die niedrigsten in dem Verband 1 × 1 m ereicht werden. Die beste Qualität in den einzelnen Klassen wurde bei dem Verband 2 × 2 m erreicht. Für die Ökotypbeurteilung wurden auch die Blattentfaltung der Bäume, die Rinderfeinheit und die Ästigkeit bewertet. In der produktionsgemäß besten Unterabteilung mit dem Verband 2 × 2 m war fast die Hälfte der Bäume *tardiflora* (spätblattentfaltend), während die dichteste Unterabteilung mit dem Verband 1,5 × 1,5 m ist der Stand ähnlich wie bei dem Verband 1 × 1 m. Der höchste Prozentsatz der Bäme mit einer glatten Rinde wurde auf der Unterabteilung mit dem breiten Verband 2 × 2 m und der niedrigste in dem Verband 1,5 × 1,5 festgestellt. Das weist auf eine gewisse Ökotypverscheidenheit im Rahmen der untersuchten Population hin. Der größte Anteil an fein verästelten Bäumen befindet sich in dem breiten Verband 2 × 2 m, gegenüber den anderen Verbänden gibt es nur einen kleinen Unterschied. Das bedeutet, daß in dem gegebenen Falle die Ästigkeit durch den Verband nicht beträchtlich beeinflußt wurde. Es wurde festgestellt, daß die Fichten auf den Versuchsflächen teilweise durch den Hallimasch (*Armillariella* Karst.) befallen sind. Die Untersuchung ergab, daß die Unterschiede in der Anzahl der befallenen Bäume auf Flächen mit einem verschiedenen Verband nur zufällig sind. Die dünnste Fläche 2 × 2 m hat die größte Bestandesgrundfläche, die anderen unterscheiden sich von ihr nur sehr wenig. Die größte Kronenfläche wird mit der Fläche mit dem Verband 1 × 1 m produziert, die kleinste auf der Fläche mit dem Verband 1,5 × 1,5 m. Die durchschnittliche Kronenbreite in 87 Jahren ist auf der Fläche in dem Verband 1,5 × 1,5 m, und ebenso die größte Kronenlänge. Die durchsshnittliche Stammlänge ist die größte auf der Unterabteilung mit dem Verband 2 × 2 m, in dem Verband 1,5 × 1,5 ist die größte Längen des gereinigten Stamms. Die Nährfläche ist die größte in dem Verban 1,5 × 1,5 und ebenso die Abstandszahl.

Aufgrund einer allgemeinen Bewertung der 87jährigen Forschung der Verbände 1 × 1 m, 1,5 × 1,5 m und 2 × 2 m in einem Fichtenbestand des trockneren Gebietes kann konstatiert werden, daß der Verband 2 × 2 m, d. i. 2500 starke Pflanzen je 1 ha praktisch in allen Kennziffern die besten Ergebnisse aufweist. Daraus kann gefolgert werden, daß die Rationalisierung der Anlage und der Erziehung von Fichtenbeständen in einem breiten Verband möglich und zweckmäßig ist.

Espacement et développement d'un peuplement d'épicéa

La rationalisation dans l'exploitation forestière et la culture des forêts exige que la densité des peuplements forestiers nouvellement formés soit convenable. Le problème en question a apparu dans un contexte analogue dès la fin du dernier siècle, donnant naissance à la dite éclaircie millimétrique tchèque. Sur l'échelle internationale on examine cette question notamment sur l'épicéa. Les essais ont cependant un caractère à long terme, de sorte que les résultats ne seront à la disposition qu'au bout de beaucoup d'années. C'est pour cette raison qu'il est nécessaire d'appliquer la méthode rétrospective et d'évaluer les parcelles d'essai fondées dans le lointain passé. Une de telles parcelles, fondées selon la méthode de l'ancien Institut de recherches forestières à Mariabrunn près de Vienne, est la parcelle expérimentale dans le district forestier Lipuvka près de Brno. Cette parcelle était fondée en plantant au printemps 1889 les plants d'épicéa de trois ans repiqués. Elle comprend trois sous-parcelles comparatives, chacune d'une superficie de 0,25 hectare. La sous-parcelle I était établie à l'écartement 1 × 1, la sous-parcelle II à l'écartement 1,5 × 1,5 et la sous-parcelle III à l'écartement 2 × 2 mètres. La parcelle se trouve dans le peuplement 215b6, les coordonnées géographiques étant à 16°37-38′ de longitude Est et à 49°20-21′ de latitude Nord. L'altitude est de 460-480 mètres, la température annuelle moyenne de 8 °C et les précipitations moyennes de 610 mm. La déclivité du terrain est de 11-17°. Il s'agit de la pente d'est et le substrat géologique est formé d'amphibole et de feldspath. Groupe de types forestiers = hêtraie à aspérule.

Nos mesures étaient effectuées en 1973 à l'âge du peuplement de 87 ans. Le nombre final d'arbres est le plus élevé sur la sous-parcelle à l'écartement 2 × × 2 m, sur la sous-parcelle à l'écartement 1,5 × 1,5 mètres étant de 15 p. 100 plus faible. Le diamètre à hauteur de poitrine est le plus grand à l'écartement 2 × 2 mètres et le plus faible à l'écartement 1 × 1 mètre. La hauteur moyenne du peuplement en 1973 est la plus faible à l'écartement 1 × 1 mètre et la plus grande à l'écartement 1,5 × 1,5 mètre, celle à l'écartement 2 × 2 mètres ne différant de cette dernière que très faiblement. La surface terrière totale du peuplement est à l'écartement 2 × 2 mètres de 17 p. 100 plus grande que celle des autres sous-parcelles. Le volume du bois gros à l'écartement 2 × 2 mètres s'élève à 124 p. 100 et à l'écartement 1,5 × 1,5 mètre à 104 p. 100 de la valeur du volume trouvé sur la sous-parcelle à l'écartement 1 × 1 mètre. La valeur de la tige moyenne est la plus grande à l' écartement 2 × 2 mètres et la plus faible à l'écartement 1 × × 1 mètre. La production totale du volume dans 87 ans est plus élevée de 10 p. 100 à l'écartement 2 × 2 mètres qu'à l'écartement 1 × 1 mètre. L'accroissement moyen annuel est de 8 p. 100 plus élevé à l'écartement clairsemé qu'à l'écartement serré. La classification des arbres selon la croissance a montré qu'il y a à l'écartement clairsemé la proportion la plus élevée des arbres dominants accusant le volume le plus élevé. La classification selon la qualité montre également que c'est le peuplement à 1,5 × 1,5 mètre et à 2 × 2 mètres d'écartement qui atteint la meilleure qualité des arbres selon les caractères biomètriques et phénotypiques et la qualité la plus mauvaise â 1 × 1 mètre d'écartement. La meilleure qualité dans les classes particulières a été atteinte à 2 × 2 mètres d'ecartement. Pour evaluer les écotypes, on estimait aussi la frondaison des arbres, la finesse de l'écorce et la richesse de la ramification. La meilleure sous-parcelle au point de vue de la production, avec un écartement de 2 × 2 mètres, accusait presque la moitié des arbres *tardiflora* (à frondaison tardive), tandis que la sous-parcelle la plus serrée à 1 × × 1 mètre d'ecartement accusait deux tiers d'arbres *praecox* (à frondaison précoce). A l'écartement 1,5 × 1,5 mètre la situation est analogue à celle que l'on trouve à l'écartement 1 × 1 mètre. Le pourcentage le plus élevé d'arbres avec l'écorce lisse a été identifié sur la sous-parcelle clairsemée à 2 × 2 mètres d'écartement. Cela laisse à penser qu'il y a une certaine différence entre les écotypes dans le cadre de la population examinée. C'est l'écartement clairsemé à 2 × 2 mètres qui accuse la proportion la plus élevée des arbres finement ramifiés, dont les autres écartement ne diffèrent d'ailleurs que très peu. Cela signifie que dans le cas donné la densité de branchage des arbres n'était pas nettement influencée par les écartements. Nous avons identifié que les épicéas sur les surfaces d'expérience sont en partie attaqués par l'armillaire (*Armillariella* Karst.). L'exploration a montré que les différences entre les nombres d'arbres attaqués ne sont, sur les surfaces à écartements différents, qu'accidentelles. C'est la surface à écartement le plus grand de 2 × 2 mètres qui accuse la surface terrière du peuplement la plus grande, les autres ne différants d'elle d'ailleurs que très peu. La surface la plus grande des houppiers se trouve sur la sous-parcelle où l'écartement est de 1 × 1 mètre et la plus faible sur celle où l'écartement est de 1,5 × 1,5 mètre. La largeur moyenne la plus grande du houppier, aussi bien que sa longueur moyenne la plus grande à l'âge de 87 ans ont été trouvées sur la sous-parcelle accusant l'écartement de 1,5 × 1,5 mètre. La longueur moyenne la plus grande de la tige a été enregistrée sur la sous-parcelle à 2 × 2 mètres d'écartement et la partie la plus longue de la tige exempte de branches sur la sous-parcelle à 1,5 × 1,5 mètre d'écartement. La capacité nutritive la plus grande a la surface où l'écartement de 1,5 × × 1,5 mètre, celle-ci accusant aussi l'indice d'intervalle entre deux tiges le plus grand.

Si nous évaluons l'ensemble de la recherche, effectuée pendant 87 ans sur les peuplements d'épicéa à 1 × 1, 1,5 × 1,5 et 2 × 2 mètres d'écartement dans la région sèche, nous pouvons constater que l'écartement à 2 × 2 mètres, c'est-à-dire 2500 plants vigoureux à 1 hectare accuse pratiquement les meilleurs résultats dans tous les indicateurs. On en peut déduire que l'établissement et l'élevage des peuplements d'epica à un écartement peu serré sont possibles et rationnels.

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FUNCTIONAL POTENTIAL AND FUNCTIONAL EFFECT OF FOREST IN ASPECTST OF FOREST PROTECTION

In a civilized region the forest has a determined function. Usually not a single function is in question, but almost always several functions are involved. The functional effectiveness of the forest is attained by taking advantage of the realities of nature and by economic activity pursuing the intentional formation of stands and their adaptation to the intended purpose. These requirements are comprehensively expressed in determining the aim of the forest.

The results of economic endeavour attempting to fulfil the aim of the determined effect of the forest are often not satisfactory. The reasons for this failure may be manifold. One reason among them is such injury to stands caused by damaging factors that the respective complex cannot attain the required functional effect. The consequence of this is either a temporary or a permanent change of the character of the forest which often requires also the change of the intended aim of the forest, or perhaps it is necessary to markedly change the silvicultural systems in conformity with the newly arisen conditions which again is reflected in the functional effect of the forest. So far, no particular emphasis being laid on the integration of forest functions, such undesired situations in the forests were mostly felt when the productive function of the forest was disturbed, if the forest was intended for timber production, or in protective forests if their function was clearly determined.

In forests unilaterally intended for timber production the task of forest protection is to create conditions ensuring the optimum production of timber with safeguards against damaging factors and for this purpose all economic, technical and biological means and methods are used which are of the required effectiveness and are also economically advantageous. In functionally integrated forest management where beside the productive function also extraproductive functions should be considered means and methods of forest protection which are currently used in forests serving only the purpose of timber production are not always acceptable. The task of forest protection in functionally integrated forest management is to determine such effects that the fulfilment of all the intended forest functions be safeguarded against damaging factors so that the total functional effect of the forest attains the maximum.

FUNCTIONAL POTENTIAL AND FUNCTIONAL EFFECT OF THE FOREST

The function of the forest can be defined as the resultant of social requirements and economic limitations on the one hand and of realities of nature and technical solutions on the other (P a p á n e k 1972). The functional potential represents the significance belonging to forest management functionally regulated in the given natural conditions and with regard to social requirements in such a way as to be able to produce material, or ideal goods, or services of the respective kind (Papánek 1972).

As follows from both definitions, in determining the forest function, or in considering the functional potential of the forest, the starting-point is the respect a) of the natural conditions in which the forest exists, and b) of the requirements claimed by society from the forest.

Natural conditions are important from the viewpoint of their capacity for forest growth, as to a certain forest type. They are considered both from the viewpoint of their usefulness for certain economic intentions and from the viewpoint of the possibility of their changing and transforming by technical means and solutions. Social requirements concerning the forest are based on human needs, or perhaps on ideas according to which these needs could be best satisfied. They are limited by economic aspects.

The functional effect of the forest expresses the degree of meeting economic and social demand (Papánek 1972). It depends mainly on the harmonization of relations between social requirements as to the functional effectiveness of the forest and the technical solution by which it should be attained on the one hand, and on the character of the forest in the given natural conditions in the framework of which these requirements should be met, on the other hand. If there is a harmony between social demands and the possibilities of phytotechnical arrangements given by natural conditions, then the assumption can be made of attaining the maximum functional effect, including the aspect of forest protection. But if there exists a disharmony between social demand and the possibilities given by nature and if the meeting of social demand requires exacting and sweeping interventions into the natural character of the forest, disproportions may arise which are deeply reflected also in the field of forest protection.

One of the marks of dynamics of the forest representing a combination of specific associations is their adaptation to given conditions and their retroaction on the properties of the environment. This process is accompanied by a number of phenomena which are not necessarily in harmony with the idea of a functionally destined forest. Such unwanted phenomena which arise in the course of forest dynamics are various disturbances of the forest, calamities, deterioration of stability, of sanitary conditions etc. In such case the forest appears to be labile and functionally unstable and its final functional effect is small. Though it is possible to influence processes in the forest which are the consequence of endogenous processes in the association, or are the expression of exogenous natural, or even anthropic factors, by some technical solutions, nevertheless this possibility is limited by the character of natural conditions, by economic aspects and especially by the final effect of the technical solution which needs not always to be in harmony with the required functional effect of the forest (e. g. the use of chemical means is excluded in some forests important for sanitary reasons).

For this reason it is necessary to take protection apects into consideration when determining the functional aim of the forest, when evaluating the functional potential of the forest. Forest protection in functionally integrated forest management must start from aspects and methods corresponding to the spectrum of forest functions.

The task of forest protection in functionally integrated forest management is, in the first place, to supply prognostic data on the endangerment of the forest by damaging agencies which is necessary as a basis for determining the aim of the forest. In the second place, it is the task of forest protection when determining economic principles assisting the attainment of the pursued functional aim to define adequately to the functional purpose of the forest the complex of preventive and repressive measures which should be carried out with regard to existing natural conditions, the present state of the forest and the social requirements.

The fulfilment of this task is possible only on the basis of an objective evaluation of stand properties as to resistance and disposition and on the basis of a long-standing prognosis of the endangerment of the forest by harmful agencies which should be taken into account.

The properties of the forest as to resistance and disposition with regard to damaging agencies can be characterized by the resistance potential of the forest. The resistance potential of the forest expresses the natural ability of the stands acquired in the existing conditions to prevent the activation of pests on forest trees and to resist the effect of abiotic damaging factors. This ability ensues from the genetically and ecologically conditioned anatomic, morphologic and physiologic properties of the different trees and from the synecologic relations of the forest association the edificator of which is the tree component. It appears in the homeostatic effects of the association.

In the dynamics of the natural forest, some stages of its development, especially the stage of "reaching maturity" (Leibundgut 1959, Korpel' 1967) are distinguished by signs which can be considered as the attribute of the optimum resistance potential of the anthropically influenced forest (e. g. commercial forest). This consists mainly in the marked homeostatic ability against the effect of exogenous and endogenous factors which maintain the forest in the state corresponding to the conditions of the environment. Such a state of the forest is the consequence of a long-lasting phytogenetically conditioned adaptation process of the forest association with respect to the conditions of the given ecotop. The character of such a forest is outwardly expressed by the specific structural distribution of the edificator of the forest ecosystem — the tree component (species composition, structure, kind and degree of canopy density).

Based on information from natural forests it is possible to derive per analogiam the resistance potential also in anthropically influenced forests, taking into consideration the tree species composition, its suitability for the given conditions of the ecotop, the structure of the stand, the form and density of canopy and its genesis. The more these signs of the stand correspond to the character of the natural forest especially in the stage of final growth, the greater will be their resistance potential.

The importance of the tree species composition, suited to the site, appears in the resistance of the stand as to stability and from the biocoenotic viewpoint. The static stability of these stands consists in the space distribution of the tree species, the statically more stable tree species improving the total static effect of the stand, in which also less stable tree species are represented (e. g. the importance of larch, beech and fir besides spruce). The resistance effect of a tree species composition suited to the site is expressed in the biocoenotic sense in retardation effects while the population density of phytophagous animals (e. g. of injurious insects) increases, by creating specific trophic and topic conditions, on the one hand, and in the other hand by the tree species composition in specially created synparasitic, predatorial and competitive relations in the animal component of the forest biocoenosis.

I. Assessment of the suitability of tree species composition as to site. — Hodnotenie stanovištnej vhodnosti drevinového zloženia

Degree	Characteristics	Criteria
1.	Tree species composition suitable as to site	Tree species (ecotypes) and their mutual relation correspond to the amplitude of the optimum to ecologically maximum permissible representation of tree species according to the typological survey (sensu Zlatník 1959). The distribution of tree species on the stand area is uniform.
2.	Less suitable tree species composition as to site	Tree species are not strange to the site, the share of most endangered tree species is by 50 and more % higher than permissible under the criteria of degree 1. Distribution of tree species on the stand area is in groups more or less uniform.
3.	Unsuitable tree species composition as to site	An essential share of the stand is formed by a tree species which is strange to the site, or a monoculture.*)

*) Note: monoculture — artifically established stand of one tree species, perhaps with an insignificant occurrence of other tree species, which is strange to the given conditions of the environment.

II. Assessment of the stand structure*) of the third age class on. — Hodnotenie výstavby porastov*) III. vekovej triedy a starších

Degree	Criteria
1	Multi-storied stand, length of conifer crowns (spruce, fir) comprises one half of the tree's height or more, vertical canopy closure, either complete, or since an early age interrupted.
2	Multi-storied stand, conifer crowns (spruce, fir) shorter than half of the height, but longer than a quarter of the height of the tree, vertical, complete canopy closure.
3	Two-storied stand, conifer crowns (spruce, fir) from half to a quarter of tree height, crown closure of the upper storey incomplete, of the lower one interrupted.
4	Single-storied stand, length of conifer crowns (spruce, fir) half of the tree's height and more, crown closure since an early age incomplete, or interrupted.
5	Two-storied stand, conifer crowns (spruce, fir) from one third to one quarter of tree height, crown closure of the upper storey suddenly interrupted or incomplete, of the lower storey interrupted.
6	Single-storied stand, length of conifer crowns (spruce, fir) from one third to one quarter of tree height, horizontal, complete, sometimes suddenly interrupted or incomplete canopy closure.

*) Note: Stand structure is in field work assessed according to the number of storeys. For younger stands special criteria apply (c. f. Stolina 1974).

In a similar sense the structure of the stand is of consequence. The distribution of tree species, the age and height structure of the stand multiply the resistance properties of the stand which are caused by a tree species composition suited to the site. The mechanism of the resistance effect of a stand differentiated as to age and height ensue from the differentiated resistance and disposition properties which are adequate to the growth and development stage of the tree species (trees).

III. Assessment of the sanitary coefficient of stands*) of the third age class on. — Hodnotenie sanitárneho koeficientu porastov*) III. vekovej triedy a starších

Degree	Characteristics	Criteria
1	Favorable sanitary coefficient	The percentage of damaged and by rot affected trees is not greater as the natural loss of the tree number during the decennium; the distribution of damaged and by rot affected trees is more or less uniform on the whole area of the stand.
2	Less favorable sanitary coefficient	The percentage of damaged and by rot affected trees is twice as high as the natural loss in the number of trees for the decennium; the distribution of the damaged trees is more or less uniform on the whole area of the stand.
3	Unfavorable sanitary coefficient	The percentage of damaged and by rot affected trees, if distributed uniformly throughout the stand, is three times as high as the natural loss of tree numbers in the decennium, or, if damaged and by rot affected trees form a centre, one and a half time or more, compared with the natural loss of the number of trees during the decennium.

*) Note: In assessing the sanitary coefficient damage with permanent, or long-lasting consequences is taken into consideration (Mechanical damage to trees, loss of assimilation organs in chronically operating damaging factors etc.). In phytopathogen factors of plant origin the degree of their aggressivity is taken into account; if the stand is infected by a very aggressive factor (e. g. *Armillaria mellea*), always degree 3 is assessed. For younger stands special criteria apply (c. f. Stolina 1974).

In the practical assessment of the resistance potential of stands the suitability of the tree species composition (including the ecotype) as to site is estimated according to typological criteria (e. g. according to the groups of forest types, sensu Zlatník 1959). The stand structure is assessed on the basis of the distribution of tree species in space and according to the height, age and diameter grouping in the stand. The canopy closure of the stand is assessed according to its form, degree and genesis which is derived from the dimensions and shape of the tree crowns. In addition, the so called sanitary coefficient of the stand is considered which expresses the distribution and relation of the number of damaged and by rot affected trees to the total number of trees in the stand.

For each of the three mentioned basic indicators of the resistance potential of the forest (suitability of tree species to site, structure and sanitary state of the stand) scales for the expression of the degree of resistance properties of the stand are constructed (Table I—III). The value of the resistance potential is determined by the sum total of values of the various pointers, using the criteria given in Table IV.

IV. Assessment of the resistance potential of stands of the third age class and older stands on the basis of indicators from Tables I-III*. — Hodnotenie odolnostného potenciálu porastov III. vekovej triedy a starších na základe ukazovateľov z tabuliek I-III*)

Degree	Characteristics	Criteria
1	Favorable	The sum total of the values of the indicators is in the amplitude: 3—5, no one of the indicators having a higher value than 2.
2	Less favorable	The sum total of the indicators is in the amplitude from 6 to 8, the indicator "Stand structure" having not a higher value than 4 and the other indicators not more than 2.
3	Unfavorable	The sum total of the indicators is in the amplitude 9—12.

*) Note: For younger stands special criteria apply (c. f. Stolina 1974).

ENDANGERMENT OF STANDS BY DAMAGING FACTORS AND THE RESISTANCE POTENTIAL OF THE FOREST

The forest, the stands, or single tree species are during their existence exposed to a greater or smaller danger of being damaged by harmful factors. But damaging factors injure stands (tree species) only in the case that their effects are greater than the ability of the stand (tree species) to resist. The injury of the stand by natural damaging factors is therefore the resultant of specific relations between damaging agencies and a certain degree of its aggressivity on the one hand and the resistance potential of the stand on the other hand (Stolina M. 1968).

The aggressivity of the damaging factor ensues both from its qualitative and quantitative properties (Pfeffer 1961). Thus e. g. snow with the specific weight 0.7 g cm^{-3} is heavy (quality) and when much snow falls (quantity) stands are crushed; *Ips typographus* is a phytophag on spruce (quality), in case of gradation (quantity) it becomes a very dangerous pest of the stands.

The harmfulness of a certain natural factor appears only in those conditions in which its quantitative properties and, consequently, also its aggressiveness can manifest itself. Abiotic damaging factors injure stands in conditions which ensue from the geographical situation of the territory and its orographic, edaphic, climatic and meteorologic conditions, especially in those instances when also the resistance potential of the stands is unfavorable, or less favorable (Stolina 1961b, Kodrík 1966). Biotic damaging factors manifest their aggressivity in specific conditions which ensue from the properties of the environment of their occurrence. The character of these factors and the possibilities of activation of these damaging factors can be determined by typologic units (Stolina 1959), the resistance potential of the stands being taken into account.

If the resistance potential of the stands is unfavourable, or less favourable, damage is more probable already at a smaller aggressivity of the damaging factor, on the contrary a favourable resistance potential of the stand enables homeostatic effects also if the aggressivity of the damaging factor is relatively considerable (C. f. Stolina 1961). On the basis of these indicators it is possible to set up long-range prognoses of the endangerment of stands by damaging factors (Stolina 1968), which are an indispensable indicator in forest management planning both in establishing economic goals of the forest, economic objectives and silvicultural systems and in detailed planning of economic measures in the various compartments (stands).

Protective prognostication should signalize dangers menacing stands by damaging factors. Its task is, at the same time, to study conditions and causes of threats or damage to stands by harmful agencies. The task of forest management in the field of forest protection is to eliminate these causes, or to change conditions in which damaging factors can operate. The means for this are, in the first place, preventive measures and, if necessary, also repressive interventions.

TASK OF FOREST PROTECTION IN CONSIDERING THE FUNCTIONAL POTENTIAL AND THE FUNCTIONAL EFFECT OF THE FOREST

One of the basic tasks in considering the functional potential of the forest is the review of natural conditions and of the possibilities of their modification in conformity with social requirements. The possibilities of controling and utilizing natural conditions in such a way that the functionally optimum effective forest be achieved, depend on the character of these conditions as well as on a number of factors which should be taken into account, including the technical possibilities of solution. With these problems also questions and tasks of forest protection are closely associated.

In this connection, the solution of tasks of forest protection is based on aspects of spatial and long-range prognosis of the menace to stands by damaging factors, i. e. on the resistance potential of stands and on the possibilities of activation of the damaging factors. Prognostic data serve as a basis for the solution of questions connected with the definition of forest functions and, besides that, also for the complex of measures which should be carried out in order to reduce the risk of damage to the forest, or to divert an immediately threatening danger. In considering the functional potential forest protection has a twofold mission: the prognostic and the solving one.

Prognostication establishes and records the conditions and possibilities of activation of damaging factors and forecasts the probability of risk to stands with regard to such a forest structure which suits best the social and economic requirements. At the same time, it should reflect also the present situation of the forest and the forms of its transition to the functionally required structure. In this way, protective prognostication directly touches upon the prognosis of the functional effect of the forest.

The solving task of forest protection consists in offering basic data and proposals for the solution of the optimum structure of the forest in the given natural conditions which permits to suppose the maximum reduction of risk as to injury caused by damaging factors. Nevertheless, it should be carefully considered how far the proposed structure corresponds with the functional aim of the forest, or to what extent it will be necessary to depart from the optimum structure of the forest in order to attain the functional intention. In connection with this again arises a number of related questions, foremost, to what extent will the intended deviation from the optimal structure increase the risk of damage to the stands.

The task of forest protection in solving problems concerning the determination of the functional potential and the supposition of the functional effect of the forest is to decide a wide range of questions connected with the diverting of immediate danger to the stands by damaging factors. Since the greatest part of the present technical means and solutions in pest control is adapted to the use in a monofunctional forest with production goals, they wil not suit at all, or to a sufficient extent, the functionally integrated forest management where besides the production function also other functions will be equally important, mainly those, in which it is a priori impossible to influence the forest ecosystem, or certain parts of the abiotic environment, by technical means (e. g. protection of water resources). Up to now there is no satisfactory replacement for such means and solutions, consequently preventive measures will in such circumstances play an important role.

CONCLUSION

With expanding progress and increasing requirements of society on the forest the solution of questions of functionally integrated forest management comes into play. This requires to reassess the forest from the viewpoint of its functional potential and functional effect. In connection with this also the task of forest protection must be reassessed. Its task in functionally integrated forest management is to offer a space and time prognosis of the threat to stands by damaging factors with respect to the present and proposed stand structure adjusted to the functional aim of the forest. For this purpose it must rely on assisting indicators as are the spatial and long-range prognosis of activation of damaging factors, the resistance potential of stands and the degree of menace derived from it. Its task is, besides that, to furnish data for the solution of the forest structure which would, on the one hand, limit the risk of damage to stands by damaging factors, and on the other hand best fulfil the functional aim of the forest. Aspects of forest protection are important for the assessment of the functional potential of the forest, the prognostic tasks touch directly upon the prognosis of the functional effect of the forest.

In functionally integrated forest management the importance of preventive measures increases since the actual technical means and solution of pest control are in some functional types a priori excluded.

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Funkčný potenciál a funkčný efekt lesa v aspektoch ochrany lesov

S rozvojom a so vzrastajúcimi požiadavkami spoločnosti na les vystupuje do popredia riešenie otázok funkčne integrovaného lesného hospodárstva. To vyžaduje prehodnocovať les z hľadiska jeho funkčného potenciálu a funkčného efektu. V súvislosti s tým sa musí prehodnocovať aj úloha ochrany lesov. Jej úlohou vo funkčne integrovanom lesnom hospodárstve je poskytnúť priestorovú a časovú prognózu ohrozenia porastov škodlivými činiteľmi pri súčasnej a pri navrhovanej štruktúre porastov orientovanej na funkčný zámer lesa. Pre tento účel sa musí opierať o pomocné ukazovatele, ako sú priestorová a dlhodobá prognóza aktivizácie škodlivých činitelov, odolnostný potenciál porastov a z toho odvodzovaný stupeň ich ohrozenosti. (Pre tento účel boli zostavené ukazovatele, ktoré sú uvedené v tabuľkách.) Okrem toho jej úlohou je poskytnúť podklady pre riešenie štruktúry lesa, ktorá by na jednej strane obmedzovala riziko poškodzovania porastov škodlivými činiteľmi, na druhej strane by optimálne spĺňala funkčný zámer lesa. Aspekty ochrany lesa sú významné pre posudzovaní funkčného potenciálu lesa, jej prognostické úlohy sa bezprostredne dotýkajú prognózy funkčného efektu lesa.

Vo funkčne integrovanom lesnom hospodárstve vzrastá význam preventívnych opatrení, pretože súčasné technické prostriedky a riešenia boja proti škodcom sú v niektorých funkčných typoch apriórne vylúčené.

Функциональный потенциал и функциональный эффект леса в аспектах лесозащиты

С развитием и ростом требований общества к лесу на первый план выступают вопросы функционально интегрированного лесного хозяйства. Это заставляет пересмотреть лес с точки зрения его функционального потенциала и функционального эффекта. В связи с этим надо пересмотреть и роль лесозащиты. В функционально интегрированном лесном хозяйстве ее роль заключается в пространственном и временном прогнозе угроза лесонасаждений со стороны вредных факторов при существующей и намечаемой в связи с функциональной ориентировкой леса структуре насаждений. Для этой цели нужно опираться о вспомогательные показатели, каковы пространственный и долгосрочный прогнозы активизации вредных факторов, резистентный потенциал лесонасаждений и выведенная на его основе степень их нахождения под угрозой. (Для этой цели составлены показатели, которые приводятся в таблицах.) Кроме того, их роль заключается в предоставлении материала для решения структуры леса, ограничивающей с одной стороны опасность повреждения насаждений вредными факторами, а, с другой, оптимально отвечающей функциональной ориентировке леса. Аспекты лесозащиты важны для оценки функционального потенциала леса, ее прогнозическая роль непосредственно касается прогноза функционального эффекта леса.

В функционально интегрированном лесном хозяйстве возрастает значение предварительных мероприятий, так как современные технические средства и методы борьбы с вредителями в некоторых функциональных типах заранее исключены.

Funktionspotential und Funktionseffekt des Waldes in Aspekten des Waldschutzes

Mit der Entwicklung und den ansteigenden Anforderungen der Gesselschaft an den Wald gelangt in der Vordergrund die Lösung der Fragen der funktionsgemäß integrierten Forstwirtschaft. Dazu ist es orforderlich, den Wald von dem Gesichtspunkt seines Funktionspotentials und Funktionseffekts umzuwerten. Im Zusammenhang damit ist auch die Aufgabe des Waldschutzes umzuwerten. In der funktionsgemäß integrierten Forstwirtschaft ist es dessen Aufgabe, eine Raum- und Zeitprognose der Bedrohung der Bestände durch schädliche Faktoren bei der gegenwärtigen und der, auf das Funktionziel des Waldes gerichteten vorgeschlagenen' Struktur der Bestände zu leisten. Zu diesem Zweck muß sich der Waldschutz an die Hilfskennziffern, wie z. B. die langfristige und Raumprognose der Aktivierung der schädlichen Faktoren, das Widerstandsfähigkeitspotential der Bestände und der daraus zu folgernde Grad ihrer Bedrohung, stützen. (Zu diesem Zweck wurden die in den Tafeln angegebenen Kennziffern zusammengestellt.) Außerdem ist es die Aufgabe des Waldschutzes Unterlagen zu geben für die Lösung der Waldstruktur, die einerseit das Risiko der Schädigung der Bestände durch schädliche Faktoren reduzieren, andererseits optimal das Funktionsziel des Waldes erfüllen würde. Die Waldschutzaspekte sind wichtig bei der Beurteilung des Funktionspotentials des Waldes, mit dessen prognostischen Aufgaben unmittelbar die Prognosen des Funktionseffekts des Waldes zusammenhängen.

In der funktionsgemäß integrierten Forstwirtschaft steigt die Bedeutung der Vorbeugungsmaßnahmen an, da die gegenwärtigen technischen Mittel und Lösungen der Schädlingsbekämpfung in einigen Funktionstypen a priori ausgeschlossen sind.

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J. Halaj

THINNINGS OF SPRUCE STANDS IN THE CZECH SOCIALIST REPUBLIC

The aim of the work is research of thinnings of spruce stands in the Czech Socialist Republic, this being done from two viewpoints:

1) Inquiry into production indices of thinnings, mainly the derivation of quantitative indices concerning the type and intensity of thinning in order to describe and to fix mathematically the type of thinning in yield tables of spruce which are at present in preparation.

2) Construction of thinning tables for spruce stands in the Czech Socialist Republic. The purpose is to derive tables of decennial thinnings in m^3/ha and of decennial thinning percents based on domestic experimental data of research plots.

The research is based on experimental data concerning repeated measurements of research plots established during 1965—1972 over the whole state territory for the construction of yield tables. The data form part of an extensive network of research plots which are established since 1965 till today over the whole territory of the state in the scope of research concerned with the preparation of yield tables for the main tree species in Czechoslovakia (spruce, fir, pine, beech and oak). All research institutions, colleges of forestry and institutes for forest management take part in the establishment of research plots. The establishment of research plots is carried out in close cooperation with operational forestry, mainly in as far as the marking and execution of thinnings on the research plots is concerned.

Research plots are established in the decennium 1965—1974 during forest taxation each year on those working units on which working plans are revised. In 1975, when the network of research plots will be established on the whole territory of the state, the first edition of yield tables will be prepared from these experimental data. It is expected that, at this time, for the mentioned five tree species about 3500 research plots will be totally established. Measurements on the established research plots are repeated every five years. All research work is directed and coordinated by the Commission for Yield Tables. Work is carried out in a centralized manner according to "Directions for the establishment and evaluation of research plots serving the construction of yield tables in Czechoslovakia" edited by the Commission for Yield Tables in 1965 and 1972. Part of the Directions are also directions for the execution of thinnings on research plots.

The research plots are established in two forms, namely as provisional and permanent research plots.

1) Provisional research plots are permanently stabilized on the ground. They comprise 0.20—0.50 ha in such a way that at least 300 trees grow on the plot. They are established representatively on all important typological units. Dendrometrical measurements on the plot comprise tree cruising, height measurements for the chart of heights, measurement of the diameter increment of the mean stem by boring, the age of the stand

is established, a detailed description of the stand and the typological classification of the plot into the forest type is carried out. Together with the measurements, in cooperation with the forest enterprise the marking of thinning for the next five years according to the thinning direction is carried out. In spruce, low thinnings of moderate intensity are principally used, at a young age also high thinnings. The thinning cycle is constant regardless of age and site, i. e. five years and coincides with the interval of repeated measurement of research plots and with the age interval of the future yield tables. Provisional research plots are established by the staff of the Institutes for Forest Management during taxation work. Guidance of the work is provided by the Commission for Yield Tables.

2) Permanent research plots are established by the personnel of research institutes and forestry colleges. These plots are permanently stabilized on the ground and have a surface of 0.20—1.00 ha. They are established in a similar method as provisional research plots, but the trees are numbered. Dendrometrical measurements are more detailed and a detailed classification of trees is carried out. They serve to a more detailed analysis of the growth and production of stands in connection with research work for the preparation of yield tables. The number of permanent research plots represents about 5—10 % from the number of provisional research plots.

Provisional and permanent research plots are repeatedly measured each five years. In repeated measurements basically the same values are determined as in establishing research plots and also a new thinning weight for the next five years is marked.

For the research of thinnings in spruce stands exclusively research plots with repeated measurements were used, where already two thinnings in the established five years' thinning cycle have been carried out. Beside that, data from several permanent thinning research plots were utilized (Pařez 1965, Vyskot 1969). Altogether, 309 research plots in the age from 24 to 100 years, on different sites and of different stocking and silvicultural treatment were used. The intensity of the foregoing tending is characterized by the level of the growing stock (Halaj 1971) which is given by the basal area of the stand per ha in dependence on the mean height. Three levels of growing stock are distinguished, the lower level 1 characterizes stands which have been so far intensively tended, the middle 2 and upper 3 level characterizes stand which have been so far very little tended.

The planning of thinning in the scope of forest taxation refers to the decennium in accordance with the validity of the working plan. The planned decennial thinning is usually executed in two operations. Therefore in this paper not the five years' thinning as carried out on the research plots are evaluated, but the decennial thinnings as planned by the forest taxation. The decennial thinning in m^3/ha is in this case equal to the sum total of volume of two subsequent five years' thinnings.

TYPE OF THINNING

Beside the traditional qualitative definition of the type of thinning by means of selected tree classes also quantitative indices of the type of thinning are used in this paper, namely the indices I_v, I_d, I_h, which are defined as the relation of volume, diameter, height of the mean thinning tree to the respective values of the total stand before thinning (Eide—Langsaeter 1941, Johnston 1967, Delvaux 1968, 1971, Décourt 1969)

$$I_v = \frac{v_m}{V_m} \tag{1}$$

$$I_d = \frac{d_m}{D_m} \tag{2}$$

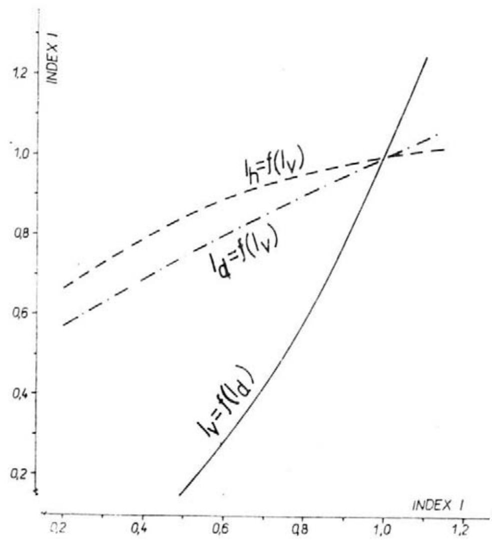
$$I_h = \frac{h_m}{H_m} \tag{3}$$

In these equations v_m, d_m, h_m mean the volume, diameter, height of the mean thinning stem, V_m, D_m H_m the same values of the stand before thinning. The indices express the relation of the average type of removed trees to the average type of trees in the whole stand, the average type being characterized by volume, diameter.

The indices proved to be a very good indicator of the type of thinning and they have the main advantage that they make more accurate the qualitative definitions of various used types of thinning, this being done simply by figures in a reasonable, clear and objective manner. They characterize numerically the various types of thinning. The index value 1.0 characterizes a neutral thinning, in which trees both under and in the crown level are removed in proportional share. Index values smaller than 1.0 characterize thinning in the lower story, by which mainly trees of lower tree classes are removed. Index values higher than 1.0 characterize thinning in the upper story, by which mainly trees of upper tree classes are removed. In domestic literature and in practice the denomination high thinning is usually applied to any thinning connected with the positive selection of crop trees and the removal of competitors in order to assist the selected trees. In doing this, also the neutral thinning is called high thinning.

Values of indices are the higher (the more lower), the higher (or lower) the character of thinning is. In thinnings with the same number of removed trees the index values are higher, if more dominant trees are removed, they are on the contrary lower, if trees of the lower story are removed in greater number.

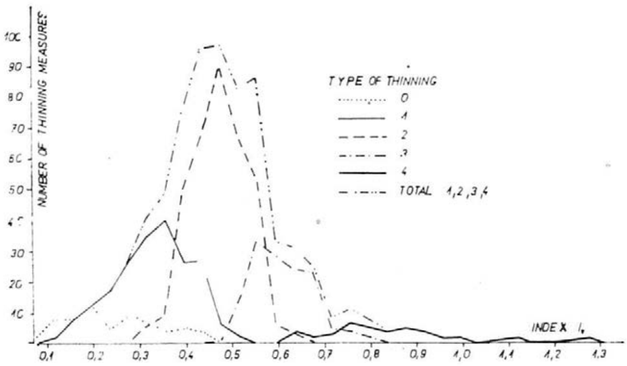
Among the indices I_v proved to be most appropriate, since its values for various used types of thinnings are mostly differentiated. For the same type of thinning the index values I_v, I_d, I_h are not the same. Moreover there exist very narrow (though not functional) correlation relations between the indices which have been evaluated from data on the research plots (Fig. 1). For types of thinnings with index values up to 1.0 the index I_v has always the lowest value, I_d a higher one and I_h the highest value. For types of thinning with index values above 1.0 on the contrary I_v has the highest value, I_d a lower and I_h the lowest one. All three indices are equal only in the neutral thinning, when the mean tree of thinning and the mean tree of the stand are identical so that in this case $I_v = I_d = I_h = 1.0$.



1. Mutual relations of indices of the type of thinning I_v, I_d, I_h. — Vzájomné závislosti indexov druhu prebierky I_v, I_d, I_h

From the qualitative viewpoint the following five types of thinning have been distinguished on the research plots:

natural automatic loosening out as a non active thinning (sign 0)
proper low thinning including sporadic intervention in the crown level (sign 1)
low thinning with moderate intervention into the crown level (sign 2)
low thinning with frequent intervention into the crown level (sign 3)
high thinning with an adequate intervention in the crown level (sign 4).



2. Frequency curves of values of the index I_v for the types of thinning 0, 1, 2, 3, 4 and their total. — Frekvenčné krivky hodnôt indexu I_v pre druhy prebierok 0, 1, 2, 3, 4 a všetky spolu

These types of thinning are quantified by the values of index I_v. In Fig. 2 frequencies of the value I_v on the research plots are shown according to the various thinnings 0, 1, 2, 3, 4 and also together for the total experimental data without respect to the type of thinning. The frequency curves of the various types of thinning are located on the axis I_v from left to right in accordance with the growing degree of crown level selection. Farthest to the left at the lowest I_v values is situated the curve of natural loosening out, the curve of the proper low thinning follows being rather overlapped by the previous curve. Next follows, also with some overlapping, the curve of low thinning with moderate intervention into the crown level, next comes the curve of low thinning with frequent intervention into the crown level and finally on the far right side at the highest I_v values is situated the curve of the high thinning. The overlapping of curves of different types of thinning is caused by the fluctuation of the I_v values in the qualitatively defined types of thinning 0, 1, 2, 3, 4. The lowest I_v values occur at the natural loosening out amounting to 0.08—0.44 (average 0.24), the proper low thinning follows with values of I_v from 0.12 to 0.52 (0.33), next comes the low thinning with moderate intervention into the crown level and the values 0.32—0.64 (0.47), succeded by the low thinning with frequent intervention into the crown level 0.48—0.80 (0.61) and the high thinning 0.64—1.28 (0.86). The total variation amplitude of I_v in Fig. 2 is in this way continously divided by the variation amplitude of the various types of thinning, the amplitude of the neighbouring types always overlapping to a certain degree. The total variation amplitude of the I_v index (if natural loosening out is not considered) amounts to 0.12—1.28, the arithmetic mean is 0.48, the standard deviation ± 0.16, the variation coefficient 32.5 %.

In the experimental data of the research plots most represented is the type of thinning marked 2, i. e. the low thinning with moderate intervention into the crown level which occurs in 48 % of instances. Next follows being represented nearly equally type 1 (proper low thinning) occurring in 28 % of instances and type 3 (low thinning with frequent intervention into the crown level) which occurs in 18 % of instances. Least frequent is type 4 (high thinning) with only 6 % of instances.

In order to fix the type of thinning by means of the index I_v at the construction of yield tables the dependence of the I_v index on the main stand values concerning the mean diameter, height, age and the number of trees per ha was studied. In the course of the overall development of stand education the I_v index should increase with growing age, because the type of thinning in older stands is being transferred into the crown level. Nevertheless, in our experimental data this tendency appeared only insignificantly. The reason is that thinnings on our research plots represent so far only the first two cuttings on the established plots, but not the tendency of development of the stand during its whole life.

INTENSITY OF THINNING

The quantitative definition of the intensity of thinning is used (Johnston 1967, Delvaux 1968, 1971, Carbonier 1971).

a) The absolute intensity of thinning (denoted v) expresses the volume in m³ per ha removed by one thinning act.

b) The relative intensity of thinning (denoted $v\%$) expresses the percentual relation of volume in one thinning act to the stand volume before thinning V

$$v\% = \frac{v}{V}\ 100\ . \tag{4}$$

In accordance with the decennial planning period of thinnings in forest taxation decennial thinnings are evaluated. The absolute intensity of the decennial thinning is called the decennial thinning in m³/ha (denoted v). It gives the total sum of two successive five years' thinnings, since a constant five years' cycle of thinnings is maintained on the research plots

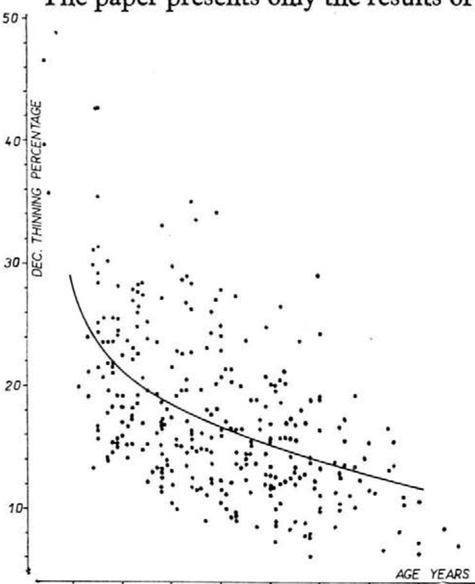
$$v_t^{10} = v_t^5 + v_{t+5}^5\ . \tag{5}$$

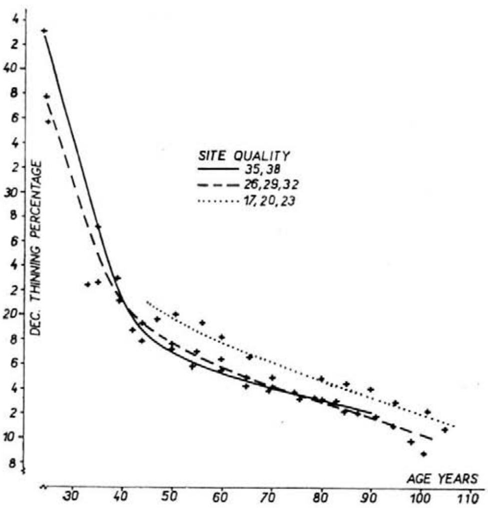
The relative intensity of the decennial thinning is called the decennial thinning percent (denoted $v\%$) and is defined as the percentual share of the decennial thinning in m³/ha in the volume of the stand before thinning at the beginning of the decennium

$$v\%_t^{10} = \frac{v_t^{10}}{V_t}\ 100 = \frac{v_t^5 + v_{t+5}^5}{V_t}\ . \tag{6}$$

In the equations v_t^{10} means the volume in m³/ha of the decennial thinning at the age t, v_t^5, v_{t+5}^5 the volume of two successive five years' thinnings at the age of t and $t+5$, V_t the volume in m³/ha of the stand before thinning at the age t.

The paper presents only the results of evaluation of the decennial thinning percents.





3. Point dispersion field of the decennial thinning percent of the research plots in dependence on age. — Bodové rozptylové pole decenálneho prebierkového percenta výskumných plôch v závislosti na veku

4. Dependence of the decennial thinning percent on age and site class. — Závislosť decenálneho prebierkového percenta na veku a bonite

The variability of the decennial thinning percents on the research plots is shown in Fig. 3, where the data of the decennial thinning percent are plotted in dependence on the age of all research plots. The field of points is compensated by the central leading curve. In the figure at first sight appears the great variability of thinning percents, being evident in all age degrees from the youngest to the oldest. The variation coefficient attains in the youngest stands around 30 years about 24 %, in middle-aged stands around 60 years about 34 %, in the oldest stands around 90 years about 32 %. The decennial thinning percent varies on the research plots in its total amplitude from 6.2 % to 46.6 %. This variability is caused by the common influence of all factors which act on the relative intensity of thinning. The most important of these factors are age, site, stocking, intensity of past stand education, present state and structure of the stand and the subjective factor consisting in the fact that different persons establishing research plots mark in otherwise equal conditions thinnings of different intensity.

FACTORS INFLUENCING THE DECENNIAL THINNING PERCENT

The effect of the main factors influencing the decennial thinning percent is reviewed.

AGE OF THE STAND

This is the most important factor influencing the decennial thinning percent. This attains its highest values exactly in the youngest stands and with increasing age it continuously drops according to a hyperbola (compare Fig. 3). The central compensating curve in Fig. 3 indicates the dependence of the decennial thinning percent on age for mean values of the remaining stand factors on the research plots (stocking, sites etc.). In the youngest age of about 30 years the decennial thinning percent of our research plots attains according to this curve on the average about 28 %, afterwards with increasing age it decreases at the beginning sharply, later more gently, till at the age of about 90 years it reaches the value of about 13 %.

SITE CLASS OF THE STAND

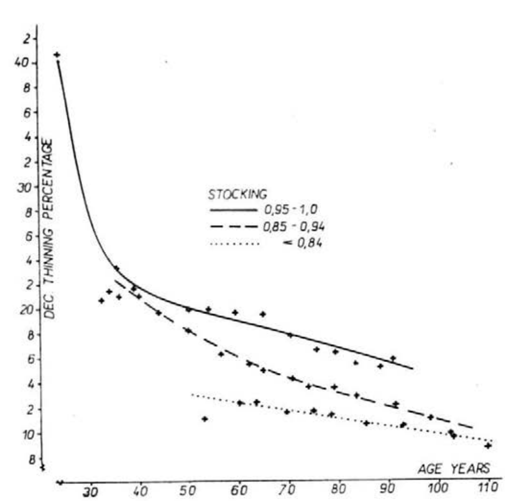
The influence of the site class on the decennial thinning percent is shown in Fig. 4. Here are for the whole experimental data plotted graphically and mathematically constructed curves of the decennial thinning percent in dependence on age for three groups of site classes, namely the site classes 17—20—23, 26—29—32, 35—38. The absolute height site classes indicate the mean height at the standard age of 100 years. From Fig. 4 follows that the decennial thinning percent depends on the site class only insignificantly showing a small increase with decreasing site class. But practically the thinning percent may be considered to be independent on the site class. The explication is that though on better site classes a higher thinning in m^3/ha is removed, the growing stock is higher, again on poorer site classes the thinning is lower, but so is the growing stock. Therefore thinning percents on better and poorer site classes are widely compensated. This is in agreement with experience gained by many other authors (Armasescu 1965, 1967, Polák 1970).

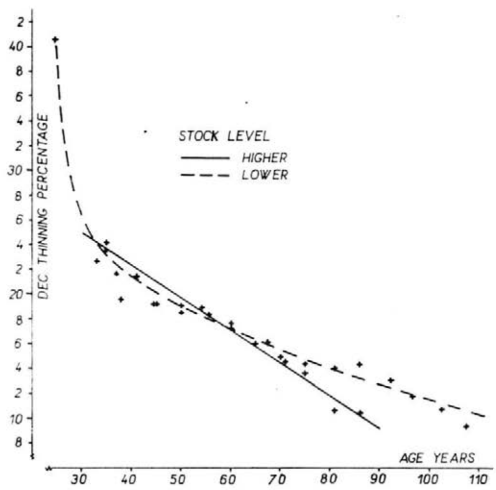
STOCKING OF THE STAND

Together with age the stocking has the greatest influence on the decennial thinning percent, namely in that direction that at equal age the percent decreases with decreasing stocking. The dependance is shown in Fig. 5, where graphically and mathematically constructed curves are plotted giving the thinning percent in dependence on age for stands of three groups of stocking, namely till 0.84, from 0.85 to 0.94 and from 0.95 to 1.00. The figure confirms that the thinning percent clearly decreases with decreasing stocking, apart from certain irregularities which are the consequence of uncomplete compensation.

INTENSITY OF PAST STAND EDUCATION

This is characterized by the levels of the growing stock of the stand. Its influence on the decennial thinning percent is shown in Fig. 6, where graphically and mathematically constructed curves of the thinning percent are plotted in dependence on age for two levels of growing stock for reasons of simplification giving the higher level of the growing stock. As can be seen from the figure, the curves of these two levels are nearly identical, or cross each other, consequently the levels of the growing stock do not influence the thinning percent. The explanation is that (like with site class) at a higher level of growing stock the decennial thinnings in m^3/ha are higher, but from a higher growing stock, at a lower level thinnings are smaller, but so is the growing stock. Therefore the decennial thinning percents at a higher or lower level of growing stock are compensated.





5. Dependence of the decennial thinning percent on age and stocking. — Závislosť decenálneho prebierkového percenta na veku a zakmenení

6. Dependence of the decennial thinning percent on age and the level of growing stock. — Závislosť decenálneho prebierkového percenta na veku a stupni zásobovej úrovne porastov

TYPE OF THINNING

The index I_v as an indicator of the type of thinning can be mathematically expressed also as the share of the thinning percent from the volume $v\%$ and taken from the number of trees $n\%$. According to equation (4) the relation exists for the thinning percent from the volume:

$$v\% = \frac{v}{V} 100 \qquad\qquad v = \frac{V \cdot v\%}{100}$$

Analogously there exists the relation for the thinning percent from the number of trees:

$$n\% = \frac{n}{N} 100 \qquad\qquad n = \frac{N \,.\, n\%}{100}$$

Then it holds good according to equation (1):

$$I_v = \frac{v_m}{V_m} = \frac{\frac{v}{n}}{\frac{V}{N}} = \frac{v \,.\, N}{V \,.\, n} = \frac{V \,.\, v\% \,.\, N \,.\, 100}{V \,.\, N \,.\, n\% \,.\, 100} = \frac{v\%}{n\%} \,. \tag{7}$$

In the equation means v, n the volume and number of trees of the thinning per ha, V, N the volume and number of trees of the stand before thinning per ha, v_m, V_m the volume of the mean tree of the thinning and of the stand before thinning.

According to equation (7) the following relation is valid for the decennial thinning percent

$$v\% = I_v \,.\, n\% = I_v \frac{n}{N} 100 \,. \tag{8}$$

According to this relation the decennial thinning percent depends at the same time on the number of trees of the thinning n and on the type of thinning I_v. Accordingly the thinning percent should be in a wide average lower in low thinnings where I_v is lower, and higher in high thinnings where I_v is likewise higher.

This dependency of the thinning percent on the type of thinning according to data from the research plots is shown in Fig. 7 as a linear direct correlation. According to it the thinning percent increases with increasing I_v. But the narrowness of the correlation is not high, the correlation coefficient $r = 0.112$. This is caused by a certain compensation of the thinning percent in dependence on the type of thinning I_v and, at the same time, on the number of trees of the thinning n according to equation (8). A high (low) thinning percent may be the resultant not only of a high (low) index I_v, but also of a great (small) number of trees of the thinning n.

A MATHEMATICAL MODEL FOR DETERMINING THE DECENNIAL THINNING PERCENT

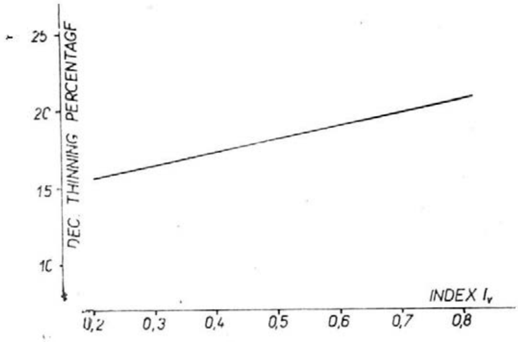
The result of the evaluation of thinnings in spruce stands of Czechoslovakia should be, among others, also tables which indicate the decennial thinning percent in dependence on the investigated main stand values i. e. on age and stocking. The variable value to be determined is in this case the decennial thinning percent $v\%$, the independent variable (given) values are the age x_1 and the stocking x_2. The mathematical model is given by the analytic expression

$$v\% = f(x_1, x_2) \,. \tag{9}$$

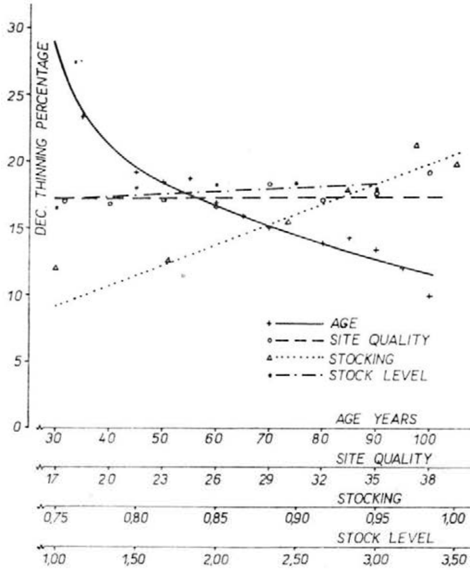
A suitable analytic form for the relation (9) is derived inductively, namely on the basis of an investigation of the form of simple correlations between the decennial thinning percent and the stand values (age, stocking etc.).

In Fig. 8 all these correlations are shown according to data from research plots, on axis x scales being given for four values, namely age, site class, stocking, and level of growing stock. Their analysis leads to the following results:

1) The correlation between decennial thinning percent and age is clearly curved, it is narrow and has the shape of a hyperbola.



7. Dependence of the decennial thinning percent on the type of thinning (the index I_v). — Závislosť decenálneho prebierkového percenta na druhu prebierky (index I_v)



8. Simple correlations between the decennial thinning percent and the stand values age, site class, stocking, level of growing stock. — Jednoduché korelácie medzi decenálnym prebierkovým percentom a porastovými veličinami vek, bonita, zakmenenie, stupeň zásobovej úrovne porastov

2) The correlation of the thinning percent with the site class does practically not exist, the corresponding regression line is nearly parallel with the axis x. The supposition made according to Fig. 4 is confirmed that the thinning percent depends only insignificantly on the site class. Consequently, the site class will not enter the mathematical model.

3) The correlation of the thinning percent with stocking is approximately linear and narrow.

4) The correlation with the level of growing stock does practically not exist, in a similar way as with the site class. Here also the supposition expressed according to Fig. 6 is confirmed that the thinning percent does not depend on the level of growing stock. Consequently, it shall not be included in the mathematical model.

The analysis confirms that the decennial thinning percent $v\%$ depends practically only on two values, namely on the age x_1 (hyperbola) and on the stocking x_2 (approximately a line). For the dependence on age, after testing the experimental data, a hyperbola of the following form proved to be most suitable:

$$v\% = a_0 + \frac{a_1}{x_1}. \tag{10}$$

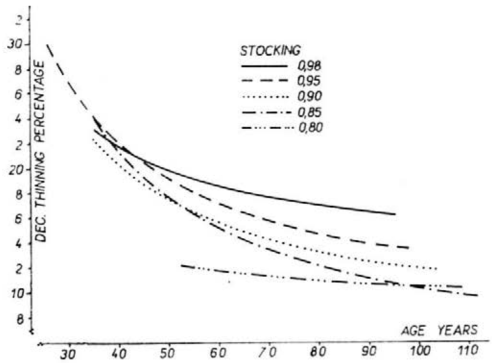
The coefficients of this hyperbola were computed by the method of least squares from experimental data of the research plots for five groups of differentiated stocking of the research plots 0.80—0.85—0.90—0.95—0.98. All computation was made with the computer Tesla 200.

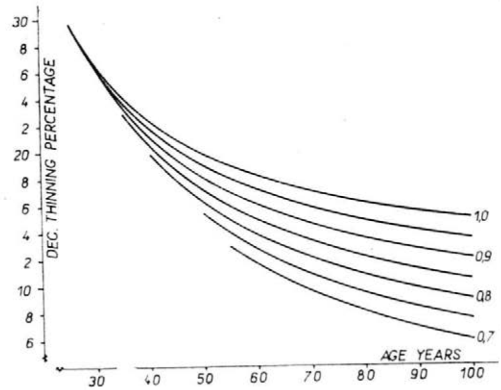
The resulting compensated hyperbolae of the dependence of the decennial thinning percent on age for these groups of stocking are shown in Fig. 9. The coefficients a_0, a_1

of equation (10) were then compensated in dependence on the stocking x_2. It appeard that the dependence of both coefficients a_0, a_1 on the stocking was approximately linear. Consequently, linear equations hold good for the dependence of coefficients:

$$a_0 = c_0 + c_1 x_2 \; , \tag{11}$$

$$a_1 = d_0 + d_1 x_2 \; . \tag{12}$$





9. Compensation of the decennial thinning percent in dependence on age for five groups of stocking. — Vyrovnanie decenálneho prebierkového percenta v závislosti na veku pre 5 skupín zakmenenia

10. Compensation of the decennial thinning percent in dependence on age and stocking. — Vyrovnanie decenálneho prebierkového percenta v závislosti na veku a zakmenení

Now, if we put into equation (10) for the coefficients a_0, a_1 the expressions from equation (11), (12), we get the equation for the determination of the decennial thinning percent in dependence on the age x_1 and the stocking x_2:

$$v\% = a_0 + \frac{a_1}{x_1} = c_0 + c_1 x_2 + \frac{d_0 + d_1 x_2}{x_1} \; .$$

Having made adaptations and changed the signs of the coefficients we get the final equation:

$$v\% = a_0 + \frac{a_1}{x_1} + a_2 x_2 + \frac{a_3 x_3}{x_1} \; . \tag{13}$$

This mathematical model fulfills the conditions which were derived from Fig. 8 for the form of simple correlations between the decennial thinning percent and the stand values. According to equation (13) the decennial thinning percent depends on the age x_1 according to a hyperbola and on the stocking x_2 in a linear form.

The coefficients of the final equation (13) are best derived by a new compensation of experimental data by the method of least squares. This was done by the computor Tesla 200. The coefficients of the equation are as follows: $a_0 = -32.425$, $a_1 = 1721.896$, $a_2 = 42.594$, $a_3 = -1236.632$.

The compensated decennial thinning percents according to equation (13) in dependence on age and stocking are shown in Fig. 10.

The narrowness of the dependence of the decennial thinning percent on age and stocking is given by the index of correlation the value of which is 0.616. The index is not very high which indicates the existence of influence of further factors on the decennial thinning percent besides age and stocking. Apparently the mentioned subjective factor asserts itself here, causing a great variability of the decennial thinning percent. Also the

I. Table of decennial thinning percent in dependence on age and stocking. — Tabuľka decenálnych prebierkových percient v závislosti na veku a zakmenení

Age Years	Stocking						
	1.00	0.95	0.90	0.85	0.80	0.75	0.70
25	29.6	29.6	—	—	—	—	—
30	26.3	26.3	26.2	—	—	—	—
35	24.0	23.7	23.3	22.9	—	—	—
40	22.3	21.7	21.1	20.6	20.0	—	—
45	21.0	20.2	19.4	18.7	17.9	—	—
50	19.9	19.0	18.1	17.2	16.3	15.5	—
55	19.0	18.0	17.0	16.0	15.0	14.0	13.0
60	18.3	17.2	16.1	15.0	13.9	12.8	11.7
65	17.6	16.5	15.3	14.1	12.9	11.7	10.6
70	17.1	15.9	14.6	13.4	12.1	10.8	9.6
75	16.6	15.3	14.0	12.7	11.4	10.1	8.8
80	16.2	14.9	13.5	12.2	10.8	9.5	8.1
85	15.9	14.5	13.1	11.7	10.3	8.9	7.5
90	15.6	14.1	12.7	11.2	9.8	8.4	6.9
95	15.3	13.8	12.3	10.8	9.4	7.9	6.4
100	15.0	13.5	12.0	10.5	9.0	7.5	6.0

influence of the type of thinning on the thinning percent according to equation (8) makes itself felt. By eventual introduction of the type of thinning (which is given by the index I_v) into the mathematical model (13) its accuracy could be increased. Otherwise the accuracy of equation (13) is relatively low, the mean error reaches the value of $\pm$ 29.7 %.

According to equation (13) data on the decennial thinning percent are presented in Table I. They apply for the age of 25—100 years with a graduation of five years, at each age for a stocking of 1.0 to 0.7 with a graduation of 0.05.

The derived data concerning the relative intensity of thinnings in spruce stands of the Czech Socialist Republic can be considered to correspond to the present silvicultural situation and needs for tending stands according to present operational usage. It can be said that the present spruce stands in a broad average are not the result of intensive education. There are still frequent instances of belated or neglected education, though in the last time the situation in tending improved. Therefore also the intensity of thinning according to the tables, being derived from experimental data of research plots, corresponds with the conditions of stands which are so far in the broad average not sufficiently tended. Consequently, by further repeated silvicultural treatment the research plots will ever more become regularly treated. It follows from this that thinning intensity on our research plots will decrease in future. Consequently also the tables of decennial thinning percents derived from the present state will change in fact in such a degree as the research plots will get into a state corresponding to regular treatment. This is valid most of all for those research plots which have been established in so far untended or very little treated stands.

In the experimental data of research plots the relative intensity of thinnings in otherwise equal conditions (equal age, stocking) varies a great deal in consequence of further signs which influence the thinning percent, but are not taken into account in the mathematical model (13). This applies mainly to the mentioned subjective factor which consist in a different evaluation of the need for stand tending by different persons establishing research plots In stands of equal age and stocking different persons mark a subjectively different intensity of thinning. Therefore the decennial thinning percent on research plots varies, there exist here light, moderate and heavy thinnings Beside this subjective factor also other signs of stand structure influence the variability of the thinning percent, but their quantification is not feasible.

The mathematical model (13) gives average (compensated) values of the decennial thinning percent with respect to the total variability in the experimental data. By this model in reality the average intensity of thinning in all experimental data is identified as the degree of moderate thinnings. But it is characterized not by the indicator of optimum production, but by the present silvicultural needs for treatment of our spruce stands.

EVALUATION OF THE EFFECT OF AGE STOCKING ON THE DECENNIAL THINNING PERCENT

We start the evaluation from the mathematical model (13). The influence of age and stocking is shown on Fig. 10, where according to equation (13) in dependence on age the curves of the decennial thinning percent for the stocking 1.0 to 0.7 with 0.05 graduation are plotted.

Fig. 10 clearly confirms the strong influence of age on the decennial thinning percent which decreases steadily with increasing age. The decrease is strongest in the youngest age, afterwards it continuously slows down.

The influence of stocking on the decennial thinning percent is also very pronounced, the percent decreases with decreasing stocking. The effect of diminished stocking is, nevertheless, not the same in every age. The hyperbolae for the stocking 1.0 to 0.7 converge considerably at the youngest age. E. g. at the age of 30 years the thinning percent is identical for the stocking 1.0—0.95—0.90. Still at the age of 35, 40 years the curves of the stocking 1.0 till 0.8 are only insignificantly differentiated. The distance of the curves distinctly increases with age and reaches its highest values in the oldest stands. At the age of 100 years a decrease of stocking by 0.1 means a decrease of the thinning percent by about 3 0 %, at the age of 60 years by 2.2 %, at the age of 40 years already only by 0.7 %. These characteristic properties of the curves of the decennial thinning percent are determined by the properties of the experimental data and appear already in the coefficients of the equation (13).

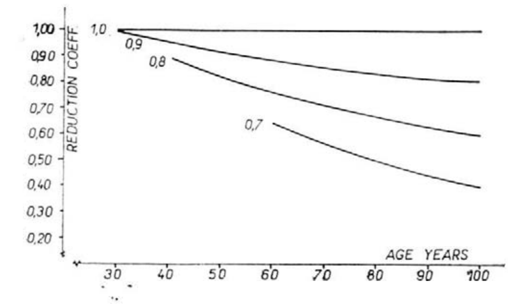
In literature and practice reduction coefficients are used for the reduction of the intensity of thinnings at full stocking (e. g. of the thinnings of yield tables) to a decreased stocking of the stand. The reduction coefficient r indicates the share of the intensity of thinning at decreased stocking z (where $z = 0.9-0.8$ etc), to the thinning at full stocking 1.0. In fact, the reduction coefficient may indicate either the share of absolute intensity of the thinning (of the decennial thinning in m^3/ha denoted v)

$$r_v = \frac{v_z}{v_{1\cdot 0}} \qquad (14)$$

or of relative intensity of the thinning (of the decennial thinning percent $v\%$)

$$r_{v\%} = \frac{v_z\%}{v_{1\cdot 0}\%} \, . \qquad (15)$$

The coefficients r_v, $r_{v\%}$ are of course mathematically different notions, their numerical values cannot be mutually compared.



11. Reduction coefficients for the decennial thinning percent at decreased stocking 0.9—0.8—0.7 of research plots of different age. — Redukčné koeficienty pre decenálne prebierkové percento pri zníženom zakmenení 0,9—0,8—0,7 výskumných plôch rôzneho veku

II. Reduction coefficients for the decennial thinning percent at decreased stocking 0.9—0.8—0.7 of research plots of different age. — Redukčné koeficienty pre decenálne prebierkové percento pri zníženom zakmenení 0,9—0,8—0,7 výskumných plôch rozličného veku

Age Years	Stocking		
	0.9	0.8	0.7
30	0.99	—	—
40	0.95	0.89	—
50	0.91	0.82	—
60	0.88	0.76	0.64
70	0.85	0.71	0.56
80	0.83	0.67	0.50
90	0.81	0.63	0.44
100	0.80	0.60	0.40

The reduction coefficients for the decennial thinning percent $r_{v\%}$ were derived from the data contained in Table I. They are given in Table II and graphically shown on Fig. 11. In accordance with equation (13) the coefficients depend not only on stocking, but also on age. For the dependance on age the rule is valid that at the same stocking the coefficient systematically decreases with increasing age. The decrease with age is pronounced. For the dependence on stocking the rule is valid that at the same age the reduction coefficient decreases with decreasing stocking, the decrease being uniform.

The reduction coefficient $r_{v\%}$ reaches for stocking 0.9 values from 0.80 to 0.99, for stocking 0.8 values from 0.60 to 0.89 and for stocking 0.7 values from 0.40 to 0.64. The amplitude refers to stands of different age. This proves that the reduction coefficient depends sensitively on age and stocking and therefore it is not reasonably possible to derive generally valid average values of coefficients regardless of age. Such simple general reduction coefficients were derived e. g. by Tjurin (1945).

SUMMARY

Research of thinnings of spruce stands in the Czech Socialist Republic serves a double purpose: 1) To derive production indices of thinnings, mainly qualitative indicators of the type and intensity of thinnings in order to fix the way of thinning in yield tables for spruce which are prepared at the same time. 2) To derive tables of thinning percents.

The research is based on 309 research plots which were established during the period from 1965 to 1972 on the territory of the Czech Socialist Republic in the scope of research work aimed at the preparation of yield tables for the main tree species of Czechoslovakia. The plots are repeatedly measured after 5 years and two thinning operations are executed on them in a five years' interval. Basically low thinnings of moderate intensity are used for spruce.

The planning of thinning in forest management is made for a decennium. Therefore also decennial thinnings are evaluated in the paper, not 5 years' thinnings as they are

executed on the research plots. Thereby, the decennial thinning in m^3/ha is equal to the sum total of two subsequent 5 years' thinnings.

The type of thinning is defined by a quantitative indicator, namely the index I_v which is given by the quotient of the volume of the mean tree of the thinning and of the stand before thinning (Johnston 1967, Delvaux 1971). The index value 1.0 characterizes the neutral thinning where trees are removed both from the crown level and from under it. Values smaller than 1.0 characterize a low thinning, higher than 1.0 a thinning in the upper story. In the thinnings carried out on the research plots 5 qualitatively described types of thinning were distinguished which are quantified by values of the index I_v. The type of thinning denoted 0 is a natural loosening out, it acquires values of I_v from 0.08 to 0.44 (average 0.24). Type 1 is the proper low thinning, it has I_v values from 0.12 to 0.52 (0.33). Type 2 is a low thinning with moderate intervention into the crown level, I_v values 0.32—0.64 (0.47). Type 3 is a low thinning with frequent intervention into the crown level, I_v values 0.48—0.80 (0.61). Type 4 is the high thinning, I_v values 0.64—1.28 (0.86). On the research plots most represented is type 2, namely in 48 % of instances, followed by type 1 represented in 28 %, type 3 by 18 % and type 4 by 6 % of instances.

For the intensity of thinnings also quantitative definitions are used (Johnston 1967, Delvaux 1971). The paper evaluates only the relative intensity of decennial thinnings which is called the decennial thinning percent and is defined as the percentual relation of the decennial thinning in m^3/ha and of the volume of the stand before thinning. The decennial thinning percent is influenced by the following factors: 1) Age of the stand, with increasing age the percent steadily drops. 2) The site class of the stand has practically no influence. 3) The stocking of the stand has a strong influence on the thinning percent which decreases with decreasing stocking. 4) The intensity of the past treatment of the stand is characterized by the level of growing stock. It has practically no influence on the thinning percent. 5) Type of thinning, given by index I_v influences also the thinning percent which increases a little with increasing I_v.

A mathematical model is derived for the determination of the decennial thinning percent $v\%$ in dependence on the age x_1 and the stocking x_2. The model was derived on the computer Tesla 200 and is given by equation (13). Thinning percents are contained in Table I in dependence on age and stocking.

Reduction coefficients are derived for the reduction of the thinning percent at full stocking to a decreased stocking of the stand. The coefficients are contained in Table II in dependence on age and stocking, they are graphically shown on Fig. 11.

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Prebierky smrekových porastov ČSR

Výskum prebierok smrekových porastov Českej socialistickej republiky sleduje dvojaký účel: 1. odvodenia produkčných ukazovateľov prebierok, hlavne kvantitatívnych ukazovateľov druhu a sily prebierok, za účelom fixovania spôsobu prebierok v rastových tabuľkách smreka, ktoré sa súčasne vyhotovujú; 2. odvodenie tabuliek prebierkových percient.

Základom výskumu je 309 výskumných plôch, ktoré sa založili v období r. 1965—1972 na území ČSR v rámci výskumných prác na vyhotovení rastových tabuliek hlavných drevín ČSSR. Plochy sú opakovane zamerané po 5 rokoch a sú na nich uskutočnené dva prebierkové zásahy v 5-ročnom intervale. V zásade sa pri smreku uskutočňujú podúrovňové prebierky miernej sily.

Plánovanie prebierok v HÚL sa robí na decénium. Preto sa aj v práci zhodnocujú decenálne prebierky, nie 5ročné prebierky, tak ako sa vykonávajú na výskumných plochách. Decenálna prebierka v m^3/ha sa pritom rovná súčtu hmôt dvoch za sebou idúcich 5ročných prebierok.

Druh prebierky sa definuje pomocou kvantitatívneho ukazovateľa, a to pomocou indexu I_v, ktorý je daný podľa rovnice (1) podielom hmoty stredného kmeňa prebierky a porastu pred prebierkou (Johnston 1967, Delvaux 1971). Hodnota indexu 1,0 charakterizuje neutrálnu prebierku, pri ktorej sa vyberajú stromy podúrovňové i úrovňové. Hodnoty menšie ako 1,0 charakterizujú podúrovňovú, vyššie ako 1,0 úrovňovú prebierku. V prebierkach výskumných plôch sa vymedzilo 5 kvalitatívne opísaných druhov prebierok, ktoré sa kvantifikujú hodnotami indexu I_v. Ich početnosti vo výskumných plochách sú znázornené na obr. 2. Druh prebierky označený 0 je prirodzené samozrieďovanie, nabodúda hodnoty I_v 0,08-0,44 (priemer 0,24). Druh 1 je čistá podúrovňová prebierka, má hodnoty I_v 0,12-0,52 (0,33). Druh 2 je podúrovňová prebierka s miernym zásahom do úrovne, hodnoty I_v 0,32-0,64 (0,47). Druh 3 je podúrovňová prebierka s častým zásahom do úrovne hodnoty I^v 0,48-0,80 (0,61). Druh 4 je úrovňová prebierka, má hodnoty I_v 0,64-1,28 (0,86). Na výskumných plochách je najviac zastúpený druh 2, a to v 48 % prípadov, potom nasleduje druh 1 zastúpený v 28 %, druh 3 v 18 % a druh 4 v 6 % prípadov.

Pre silu prebierok sa užíva tiež kvantitatívna definícia (J o h n s t o n 1967, D e l v a u x 1971). Práca zhodnocuje len relatívnu silu decenálnych prebierok, ktorá sa označuje ako decenálne prebierkové percento a je definované podľa rovnice (6) ako percentický podiel decenálnej prebierky m^3/ha vo veku t a hmoty porastu pred prebierkou. Celková variabilita decenálneho prebierkového percenta výskumných plôch je znázornena na obr. 3, kde sú vynesené prebierkové percentá všetkých výskumných plôch v závislosti na veku. Na decenálne prebierkové percento vplývajú tieto faktory: 1. vek porastu — so stúpajúcim vekom percento trvale klesá (obr. 3); 2. bonita porastu nemá prakticky žiaden vplyv (obr. 4); 3. zakmenenie porastu veľmi vplýva na prebierkové percento, ktoré klesá s klesajúcim zakmenením (obr. 5); 4. intenzita doterajšej výchovy porastov sa charakterizuje stupňom zásobovej úrovne porastov — nemá na prebierkové percento prakticky žiaden vplyv (obr. 6); 5. druh prebierky daný indexom I_v vplýva tiež na prebierkové percento, ktoré sa málo zvyšuje so stúpajúcim I_v (obr. 7). Podľa rovnice (8) prebierkové percento závisí na druhu prebierky (index I_v), na počte stromov prebierky n a porastu pred prebierkou N.

Odvodzuje sa matematický model pre určenie decenálneho prebierkového percenta v % v závisloti na veku x_1 a zakmenení x_2. Model sa odvodil na samočinnom počítači Tesla 200 a je daný rovnicou (13). Graficky je znázornený na obr. 10, kde sú vyrysované krivky prebierkového percenta v závislosti na veku pre zakmenenie 1,0 až 0,7. Prebierkové percentá sú tabelované v tabuľke I v závislosti na veku a zakmenení.

Odvodzujú sa redukčné koeficienty pre redukciu prebierkového percenta pri plnom zakmenení na znížené zakmenenie porastu. Podľa rovnice (15) sú redukčné koeficienty udané podielom prebierkového percenta pri zníženom a plnom zakmenení 1,0. Koeficienty sú tabelované v tabuľke II v závislosti na veku a zakmenení, graficky sú znázornené na obr. 11.

Прореживание еловых насаждений ЧСР

Научное исследование прореживаний еловых насаждений в Чешской Социалистической Республике преследует две цели: 1. составление производственных показателей прореживаний, главным образом количественных показателей вида и интенсивности прореживания для зафиксирования способа прореживания в таблицах роста ели, которые параллельно разрабатываются; 2. составление таблиц процентов прореживания.

Основой для научного исследования послужило 309 опытных площадей, заложенных в период 1965—1972 гг. на территории ЧСР в рамках научно-исследовательских работ по изготовлению таблиц роста главных древесных пород ЧССР. Площади повторно подвергаются измерениям спустя 5 лет и на них осуществляются два прореживания с 5-летним интервалом. В принципе у ели производятся низовые прореживания умеренной интенсивности.

Прореживание лесных насаждений в рамках лесоустройства планируется на десять лет. Поэтому и в данной работе производится оценка десятилетних прореживаний, а не пятилетних, как это делается на экспериментальных площадях. Десятилетнее прореживание, выраженное в м^3/га, при этом равно сумме массы двух следующих друг за другом 5-летних прореживаний.

Степень интенсивности определяется с помощью квантитативного показателя, а именно с помощью I_v, полученного по уравнению (1) отношением массы среднего ствола прореживания к насаждению до прореживания (Д ж о н с т о н 1967, Д е л ь в о 1971). Значение индекса 1,0 характеризует нейтральное прореживание, при котором выбираются низовые и верховые деревья. Значения меньше 1,0 характеризуют низовое а значения выше 1,0 верховое прореживание. При прореживаниях экспериментальных площадей различалось 5 в качественном отношении описанных видов прореживаний, которые квантифицируются значениями индекса I_v. Их частота на экспериментальных площадях изображена на рис. 2.

Вид прореживания, обозначенный O — естественное самоизреживание, — приобретает значение I_v 0,08—0,44 (среднее 0,24). Вид 1 представляет собой настоящее низовое прореживание и имеет значение I_v 0,12—0,52 (0,33). Вид 2 — низовое прореживание со слабой тенденцией к верховому прореживанию, значение I_v 0,32—0,64 (0,47). Вид 3 — это низовое прореживание с частыми переходами в верховое, значение I_v 0,48—0,80 (0,61). Вид 4 является верховым прореживанием и величины I_v составляет 0,64—1,28 (0,86). На опытных площадях больше всего представлен вид 2, а именно в 48 % случаев, затем следуют вид 1, представленный в 28 %, вид 3 в 18 % и вид 4 в 6 % случаев.

Для интенсивности прореживаний также применяется количественное определение (Джонстон 1967, Дельво 1971. Работа оценивает лишь относительную интенсивность десятилетних прореживаний, которая обозначается как десятилетний процент прореживаний и определяется по уравнению (6) как процентная доля десятилетнего прореживания м^3/га в возрасте t и массе насаждения до прореживания. Общая вариантность процента прореживания опытных площадей изображена на рис. 3, на котором отмечены проценты прореживания на всех опытных площадях в зависимости от возраста. На десятилетние проценты прореживания влияют следующие факторы: 1. Возраст насаждения: с возрастом процент постоянно понижается (рис. 3). 2. Бонитет насаждения практически не оказывает никакого влияния (рис. 4). 3. Полнота насаждения сильно влияет на процент прореживания, который падает с понижающейся полнотой насаждения (рис. 5). 4. Интенсивность проведенных до сих пор мероприятий по воспитанию насаждений характеризуется степенью запасного уровня насаждений. Не оказывает на процент прореживания в сущности никакого влияния (рис. 6). 5. Вид прореживания, заданный индексом I_v, влияет также на процент прореживания, который с возрастающим I_v мало повышается (рис. 7). По управнению (8) процент прореживания зависит от вида прореживания (индекс I_v), от числа деревьев прореживания n и насаждения до прореживания N.

Выводится математическая модель для определения десятилетнего процента прореживаний в % в зависимости от возраста x_1 и полноты насаждения x_2. Модель была выведена на электронновычислительной машине Тесла 200 и определяется уравнением (13). Графически эта модель изображена на рис. 10, где зарисованы кривые процента прореживания в зависимости от возраста для полноты насаждения 1,0—0,7. Проценты прореживания приведены в таблице 1 и упорядочены соответственно возрасту и полноте насаждения.

Выведены редукционные коэффициенты для редукции процента прореживания при полной полноте насаждения до пониженной полноты насаждения ели. Согласно уравнению (15), редукционные коэффициенты определяются долей процента прореживания при пониженной и полной полноте насаждения 1,0. Коэффициенты упорядочены в табл. 2 соответственно возрасту и полноте насаждения и графически изображены на рис. 11.

Durchforstungen der Fichtenbestände in der ČSR

Die Forschung der Durchforstungen der Fichtenbestände in der Tschechischen Sozialistischen Republik ist auf zwei Ziele gerichtet: 1. Ableitung der Durchforstungenproduktionskennziffern, insbesondere der Quantitätskennziffern der Art und Stärke der Durchforstungen zwecks Fixierung der Durchforstungsmethoden in den Fichtenertragstafeln, die gleichzeitig angefertigt werden. 2. Ableitung der Durchforstungsprozenttafeln.

Als Grundlage für die Forschung dienen 309 Versuchsflächen, die in der Zeit 1965—1972 auf dem Gebiet der ČSR im Rahmen der Forschungsarbeiten zur Anfertigung der Ertragstafeln für Hauptholzarten der ČSSR angelegt wurden. Die Flächen werden wiederholt nach 5 Jahren eingemessen und es werden auf ihnen zwei Durchforstungseingriffe in einem 5-jährigen Intervall durchgeführt. Bei der Fichte werden grundsätzlich Niederdurchforstungen einer mäßigen Stärke durchgeführt.

Die Planung der Durchforstungen erfolgt in der Forsteinrichtung für das Dezennium. Daher werden auch in der Arbeit dezennale Durchforstungen bewertet und nicht 5jährige Durchforstungen, so wie diese auf den Versuchsflächen erfolgen. Die dezennale Durchforstung m^3/ha gleicht dabei der Summe der Massen von zwei hintereinander folgenden 5jährigen Durchforstungen.

Die Art der Stärke wird mit Hilfe der Quantitätskennziffer, und zwar mit Hilfe des Indexes I_v, der nach der Gleichung (1) mit dem Teilwert der Mittelstammasse der Durchforstung und des Bestandes vor der Durchforstung (J o h n s t o n 1967, D e l v a u x 1971) gegeben ist, definiert. Der Indexwert 1,0 charakterisiert eine neutrale Durchforstung, bei der unterständige und mitherrschende Bäume selektiert werden. Werte niedriger als 1,0 charakterisieren die Niederdurchforstung, die Werte höher als 1,0 charakterisieren die Hochdurchforstung. Bei Durchforstungen der Versuchsflächen wurden 5 qualitativ bezeichnete Durchforstungsarten differenziert, die mit Werten des I_v-Indexes quantifiziert erden. Ihre Häufigkeiten an den Versuchsflächen werden in Abb. 2 dargestellt. Die mit O bezeichnete Durchforstungsart ist die natürliche Durchleuchtung die den Wert I_v 0,08-0,44 (Durchschnitt 0,24) erreicht. Die Art 1 ist eine reine Niederdurchforstung, von einem Wert I_v 0,12-0,52 (0,33). Die Art 2 ist eine Niederdurchforstung mit einem mäßigen Eingriff in Hochstämme, Werte I_v 0,32-0,64 (0,47). Art 3 ist eine Niederdurchforstung mit einem häufigen Eingriff in Hochstämme, Werte I_v 0,48-0,80 (0,61). Art 4 ist eine Hochdurchforstung; sie hat die Werte I_v 0,64-1,28 (0,86). Auf den Versuchsflächen ist am häufigsten die Art 2, und zwar in 48 % der Fälle vertreten, dann folgt die Art 1 mit 28 %, die Art 3 mit 18 % und die Art 4 mit 6 % der Fälle.

Für die Durchforstungsstärke wird auch eine quantitative Definition (J o h n s t o n 1967, D e l v a u x 1971) eingesetzt. In der Arbeit wird nur die relative Stärke der dezennalen Durchforstungen bewertet, die als der dezennale Durchforstungsprozentsatz bezeichnet und nach der Gleichung (6) als Prozentteilwert der dezennalen Durchforstung m³/ha im Alter t und der Bestandesmasse vor der Durchforstung definiert wird. Die gesamte Variabilität des dezennalen Durchforstungsprozentsatzes der Versuchsflächen wird in Abb. 3 dargestellt, wo die Durchforstungsprozentsätze aller Versuchsflächen in Abhängigkeit von dem Alter eingetragen sind. Der dezennale Durchforstungsprozentsatz wird durch folgende Faktoren beeinflußt: 1. Alter des Bestandes, mit dem ansteigenden Alter sinkt der Prozentsatz dauernd herab (Abb. 3). 2. Die Bonität des Bestandes hat praktisch keinen Einfluß (Abb. 4). 3. Die Bestockung hat einen starken Einfluß auf den Durchforstungsprozentsatz, der mit der abnehmenden Bestockung sinkt (Abb. 5). 4. Die Intensität der bisherigen Bestandeserziehung wird mit dem Grad des Vorratsniveaus der Bestände charakterisiert. Sie wirkt auf den Durchforstungsprozentsatz praktisch keinen Einfluß aus (Abb. 6). 5. Der Durchforstungsprozentsatz wird auch von der mit dem Index I_v gegebener Durchforstungsart beeinflußt, in dem mit dem ansteigenden I_v dieser ein wenig steigt (Abb. 7). Nach Gleichung (8) hängt der Durchforstungsprozentsatz von der Durchforstungsart (Index I_v), von der Anzahl der Bäume bei der Durchforstung n und von dem Bestand vor der Durchforstung N ab.

Es wird ein mathematisches Modell für die Bestimmung des dezennalen Durchforstungsprozentsatzes in % in Abhängigkeit von dem Alter x_1 und der Bestockung x_2 abgeleitet. Das Modell wurde auf dem automatischen Rechner Tesla 200 abgeleitet und ist mit der Gleichung (13), gegeben. Graphisch ist es auf Abb. 10 dargestellt, wo die Kurven des Durchforstungsprozentsatzes in Abhängigkeit von dem Alter für Bestockung 1,0 bis 0,7 eingezeichnet sind. Die Durchforstungsprozentsätze sind in Tab. I in Abhängigkeit von dem Aiter und von Bestockung tabelliert.

Es werden die Reduktionskoefizienten für die Reduzierung des Durchforstungsprozentsatzes bei voller Bestockung auf die verminderte Bestockung abgeleitet. Nach Gleichung (15) werden die Reduktionskoeffizienten mit dem Anteil des Durchforstungsprozentsatzes bei einer verminderten und vollen Bestockung 1,0 angegeben. Die Koeffizienten sind in Tab. II in Abhängigkeit von dem Alter und von der Bestockung tabelliert, graphisch sind die auf Abb. 11 dargestellt.

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GAME KEEPING IN CZECHOSLOVAKIA AND ITS RESULTS

Czechoslovak game management may rightly boast of a tradition that embraces tens of years. Achievements in this kind of activity have ranked Czechoslovakia among the countries which occupy the foremost positions in the world. As evidence in support of this statement be mentioned, on the one hand, the annual abundant kills of small game, on the other hand, the ever-increasing trophy value of hoofed animals, which the world public has lately had enough opportunity to realize at the international displays of trophies and the world expositions of game management. This is so not only because there are exceptionally favourable conditions for the raising of game in Czechoslovakia, of the small species in particular, but also due to the assistance given to the development of game management by organs of the Communist Party of Czechoslovakia — the present leading political force in this country, further by the Government and other bodies and institutions. The development of game management along well-thought-out lines dates back to 1948, when the foundations of socialist game management were laid. At present, Czechoslovak game management may be characterized as a productional and special-interest activity in which thousands of hunters are taking part — voluntary workers who, by the work done during the spare time and on their own initiative, produce values that amount to hundreds of millions of crowns. It may therefore rightly be claimed that Czechoslovak game management has become a socialist game management in character.

THE PLACE OF GAME MANAGEMENT IN CZECHOSLOVAK SOCIALIST SOCIETY

All of the problems related to game management in Czechoslovakia have been settled by Law No. 23/1962 Sb. (Law Gazette) on Game Management and by other provisions in execution of it. This Law defines the place of game management in the Czechoslovak Socialist Republic, and it provides that game management as one branch of agricultural and silvicultural production is responsible, in accord with the needs of a socialist society and conformity to the National Economic Development Plan, for due raising, improvement by breeding, protection and hunting of game just as for an economic utilization of bagged game. The care of a planned furtherance of game management is the interest of the whole Czechoslovak society. The socialist system creates conditions for the widest possible circle of the working people to take part in the control of game management and the excercise of game management rights.

The scientific and research work in the sector of game management has been carried out in stations of the following organizations: The Research Institute of Forestry and Game Management at Zbraslav-Strnady; The Research Institute of Forestry at Zvolen; The State Veterinary Institute for Game at Jihlava. Further working places concerned with problems of game management have been established in the School of Forestry, Brno University of Agriculture, Brno; the School of Forestry, Zvolen University of Forestry, Zvolen; and in some other agricultural and veterinary schools of university level.

Over the five-year period 1971—1975, the problems under the general heading reading „Biology of Game Raising and Diseases and Control of Game Damage“ have been studied in the sector of game management and economy, as part of the aproved National Research Plan. This general project comprises the following research projects:

1. biology and raising of game,
2. research of the possibilities of increasing efficiency in small game raising,
3. complex provision toward improving substantially the raising of some hoofed game species,
4. research of external factors affecting game in an adverse manner,
5. control of game damage to forest stands,
6. game management development and prospects in Czechoslovakia.

These research projects have been divided into a total of 35 partial studies conduced by teams of research workers and individual researchers from the research institutes and institutions as mentioned above. The methods to be applied in treating the projects and partial tasks are approved by respective co-ordinating institutions under supervision of responsible co-ordinators, and the terms for solution are fixed. Individual researchers must then defend in argument the results of research in the presence of a panel of experts.

The wider public concerned with game management is presented here the results of research obtained so far in Czechoslovakia, together with the practical achievements in game raising and economy.

The total area set aside for hunting purposes in Czechoslovakia amounts to 11,567.501 hectares in which the Czech Socialist Republic shares 7,194.142 hectares and the Slovak Socialist Republic 4,373.359 hectares. To exercise the rights of game management is allowed on hunting grounds only; these, upon suggestion of socialist organizations, are approved by respective District National Committees. The area of the hunting ground as provided by law should not be less than 500 hectares, the exeptions to this rule being enclosures, hunting grounds supervised by research institutes, and the like. In 1973 the average size of the hunting ground in Czechoslovakia was 1.409 hectares; in the Czech Socialist Republic this average amounted to 1.215 and in the Slovak Socialist Republic to 1.912 hectares.

The so-called special hunting grounds are grouped with those discussed above; enclosures and pheasantries may be included in this special type. The estimates made as if on December 31, 1972 indicated the total area of enclosures and pheasantries in Czechoslovakia to be 38.245 and 156.023 hectares, respectively. In the Czech Socialist Republic the former occupied 23.313 hectares, in the Slovak Socialist Republic 14.932 hectares; the respective figures for the latter were 94.965 and 61.058 hectares.

THE WAY OF EXERCISING THE RIGHTS OF GAME MANAGEMENT

In an effort of providing that the exercise of the game management rights and control may be shared by the widest possible circle of the working people in Czechoslovakia, the greater part of approved hunting grounds are let to socialist organizations through the Associations of Hunters, these exercising the game management rights thereon. This explains why the Co-operative Farms regularly lease all of their hunting grounds, the State farms do the same except for those referred to as reserved, and of the hunting grounds owned by the State Forests some 60—70 per cent are let out.

The Associations of Hunters are defined as the socialist organizations under which the working people in town and country possessing due shooting licence associate to exercise in common the game management rights. Membership in the organization for every hunter is limited to one such association only. An indispensable condition for obtaining the valid shooting licence is to pass special examination in game management (first shooting licence) and become member of either the Czech or Slovak Association of Hunters.

In Czechoslovakia no individual is allowed to hire a hunting ground. In hiring the hunting ground from a socialist organization, the Association of Hunters is bound to pay a certain sum of money to legal users of the hunting land, which has been specified by official announcement of the Ministry of Agriculture and Foodstuffs. The rate of charge is dependent upon the game species kept on the particular hunting ground and upon quality class of the hunting ground. This rate is generally kept so low as to allow, in compliance with the socialist character of Czechoslovak game management, all citizens of the country to take part in the exercise of the game management rights, even those who have retired and their incomes are not high. Thus, for instance in 1972, the total sum paid for the hire of all hunting grounds amounted to 8,885.441 Kčs, which, when calculated per hectare area, made an average of 0.96 Kčs.

Killed game is considered the property of the hunting association; this may either keep it for its own use or sell it. The takings for sold game, or for delivered live game, are credited with the association's account. The association of hunters is bound to settle the losses in agriculture and silviculture that have resulted from exercise of the game management rights, just as those due to the game damage, in compliance with respective legal regulations. On behalf of the Ministry of Agriculture and Foodstuffs the associations of hunters are supervised by pertinent organizations affiliated to the Czech or Slovak Union of Hunters.

The voluntary work done by sportsmen-hunters in their associations acts toward strengthening the alliance of workers and peasants; in doing so, they evidence that game management is not only an industry concerned with production but also an activity of special interest that has developed into an important kind of active relaxation for the working people. The results of their work performed during the recent period have offered enough evidence that the working people in this country are capable of raising Czechoslovak game management to a higher level than was the one at the time of the capitalist regime.

THE HUNTER'S CARE OF GAME

The breeding of game in the hunting grounds can prove successful on the assumption that the principles of the hunter's care of game are strictly observed. The person made responsible for this on every hunting ground, which has been provided by law, is referred to as ‚game manager'. The notion, ‚the hunter's care of game', has a relatively broad meaning in the socialist game management. In the first place, it includes the care aimed at improving the carrying capacity of the hunting ground and environmental conditions for the life of game, and the care of game during the winter hardships; this consists mainly in the systematic additional feeding of game, the foods supplied in sufficient amounts and good quality; further the care covers the protection of utility game against noxious game species and the animals held noxious in game management (such as roving dogs, cats, and the like); veterinary care, protection against incompetent people, and provision for necessary coverts and peace to game abiding on the hunting ground, which in particular holds true for the periods when game is subject to biological troubles (such as antlering, time of gestation, throw and upbringing of the young, brooding of feathered game species etc.). In the wider sense the notion also includes the running kill through which those individuals or groups are culled from the populations of individual game species that have

I. Stocks of utility game species in Czechoslovakia, estimates as if March 31, 1973

Game species	Number	Game species	Number
Red deer	45.038	Hare	1,448.945
Fallow deer	6.981	Rabbit	65.252
Moufflon	10.684	Partridge	1,115.884
Roe deer	289.150	Pheasant	1,354.215
Wild boar	17.203		

References: Výkaz Mysl (MZVž-ČSR) 1-01 O jarním kmenovém stavu zvěře k 31. 3. 1973. — Výkaz Poľov (MPV-SSR) 1-01 o jarnom kmeňovom stave zveri k 31. 3. 1973

II. Stocks of some rare game species in Czechoslovakia, estimates as if March 31, 1973

Game species	Number	Game species	Number	Game species	Number
Bear	471	Sika deer	816	Capercailzie	3.961
Lynx	652	American deer	56	Heath cock	10.017
Wild cat	2.068	Chamois	1.356	Hazel grouse	12.080
		Bezoar goat	27	Bustard	697

References: Výkaz Mysl (MZVž-ČSR) 1-01 o jarním kmenovém stavu zvěře k 31. 3. 1973. — Výkaz Poľov (MPV-SSR) 1-01 o jarnom kmeňovom stave zveri k 31. 3. 1973 been found undesirable in respect of breeding. In doing so, hunters assist in improving, via selection, the quality of game stocks from the aspects of health condition, weight, and development of high-score trophies.

THE STOCKS OF GAME

Factual stocks of the utility game based on the physical census conducted as if March 31, 1973 are shown in Table I; while those of the rare game species in Czechoslovakia are included in Table II. The Tables include all game of the given species that occurred in Czechoslovak hunting grounds on the above date, both in free and special (enclosures and pheasantries being meant in the latter) hunting grounds.

In an effort of securing due harmony among the interests of agriculture, forestry, and game management and to prevent serious losses in agriculture and silviculture, the hunting grounds of Czechoslovakia are grouped under quality classes for the major game species. There are four such quality classes; Class I includes hunting grounds characterized by the best conditions for game raising, while Class IV covers those with the worst conditions. Within each quality class are then fixed the so-called standardized spring stocks for major game species that are being kept in the particular hunting ground and can be represented therein without being potentially dangerous in respect of causing unbearable damage to agricultural or silvicultural stands. Table III below shows these standardized stocks for major game species (red deer, fallow deer, moufflon, roe deer, wild boar, hare, partridge, and pheasant), together with numbers of individual game species and areas of the hunting grounds in which respective game species are kept.

The Red Deer

In Czechoslovakia, red deer is raised in forest hunting grounds that cover a total area of 2,392.916 hectares; the greater part of this area are free hunting grounds, enclosures being represented in a relatively small extent only. The census made in the spring of 1973 revealed the stock of red deer to be 45.038 head, which meant 151 per cent of the standardized spring stock, the fixed figure being 29.723 head. From a comparison of these two data follows that the red-deer hunting grounds in Czechoslovakia were (and still are) ‚overloaded' in the greater part of instances.

In an effort of solving this adverse situation, the so-called red-deer breeding regions were established in 1961, as suggested by the late Assist. Professor Dr. Ing. J. Nečas (School of Forestry, University of Agriculture, Brno), one of the foremost experts in game management. In these regions was then initiated the project of planned red-deer raising, in accord with the principles developed by Dr. Ing. J. Nečas. Implementation of the principles provided conditions for gradually obtaining the desired idea of factual red-deer stocks and their structures in rounded-off regions the areas of which ranged from 10.000 to 50.000 hectares. To attain this was impossible before within the usual, small-size hunting grounds, for the radius within which the movement of one

III. Standardized spring stocks for major species of utility game

Species	Number	Area, ha	Species	Number	Area, ha
Hoofed game			Small game		
Red deer	29.723	2,392.916	Hare in field	1,259.672	6,254.959
Fallow deer	5.362	163.425	Hare in forest	194.944	1,986.460
Moufflon	6.707	237.934	Partridge	1,724.335	4,650.816
Roe deer	247.149	5,240.268	Pheasant in pheasantry	133.679	166.102
Wild boar	5.020	416.296	Pheasant in free hunting ground	919.946	3,280.042

References: Výkaz Mysl (MZVž-ČSR) 1-01 o jarním kmenovém stavu zvěře k 31. 3. 1973. — Výkaz Poľov (MPV-SSR) 1-01 o jarnom kmeňovom stave zveri k 31. 3. 1973 red-deer group occurs reaches far beyond boundary of the usual hunting ground. And this was doubtless the main reason for the undesirable ‚overloading' by red deer during the previous years. As a result of the above arrangement the raising of red deer outside the red-deer regions could be discontinued, with the exception of quite extraordinary cases.

At present, there are altogether 55 red-deer regions in Czechoslovakia, and all of the red-deer hunting grounds have been grouped under them. The management in each region has been placed in the hands of pertinent Regional National Committee which sets up, to this end, a board of advisers selected among local experts in red-deer rearing.

The red deer kept in enclosures is less numerous; target stocks of game have been fixed for enclosures in Czechoslovakia, in dependence upon local conditions. These special hunting grounds in which the intensive method of red-deer raising is practised are expected to produce, in the years to come, vigorous trophy game for the kill by sportsmen-hunters and, at the same time, high-quality breeding animals for the purpose of stocking.

The Fallow Deer

Fallow deer in Czechoslovakia is kept largely in enclosures; the scattered populations that live in free hunting grounds are but few in number. On the whole, we may say that stabilization has been achieved in this game species; the 1973 estimate indicated the factual number as 6.981 head, which meant 130 per cent of standardized stock fixed at the level of 5.363 head. From the standpoint of rearing, this difference is far from causing troubles, for under the conditions of enclosures the target stocks can easily be accomodated to suit the changing situation in nutrition and the general level of care given to the game species.

Considered from the standpoint of quality, in particular from that of the development of trophies, the fallow deer kept in Czechoslovakia may be classed as rather below the standard. The same holds true for the fallow-deer populations that live in free hunting grounds.

The Moufflon

The raising of moufflons in Czechoslovakia has attained the world top level, and the animals produce record trophies. But Czechoslovakia has been holding another primacy in the rearing of moufflon; more than one third of its total number in the world is kept in this country. The spring census of 1973 indicated the factual number of this game species as 10.684 head, which meant 159 per cent of the standardized stock fixed at the level of 6.707 head.

The greater part of the present moufflon stock live in free hunting grounds, where adult males produce mightiest trophies when about seven years of age. The rearing is intentionally centred in definite localities characterized by highly suitable natural and economic conditions, with stony ground and a drier type of mineral soil. In doing so, we gradually develop typical moufflon rearing regions.

Besides the rearing in free hunting grounds, the moufflon is also kept in deer parks, frequently together with fallow deer to which it is relatively tolerant. Under these conditions of raising the game species, too, produces trophies of very good quality in some cases.

The Roe Deer

Roe deer is the most abundant game species in Czechoslovakia, practically occuring in all hunting grounds, similarly as the hare. The varied natural and economic conditions of Czechoslovak territory doubtless are beneficial to the raising of roe deer. During the recent decades, due to the rapidly progressing rationalization of agricultural production, numerous populations of typical field roe deer have developed in areas where commassation was effected; while before, under the small-area method of farming, this game species used to live largely in the forest. The spring census of 1973 revealed that the factual stock of roe deer was 289.150 head, which meant 117 per cent of the standardized stock fixed at 247.149 head. This excess, which occurs in places, usually results in marked degradation of the species quality, both in its weight and the development of trophies. Also the damage caused by the game to agricultural and silvicultural stands tends to increase in such cases.

The roe deer of Czechoslovakia produces trophies that may be graded as rather below the standard, which is largely accounted for by improper breeding. It is true that, under the conditions of ordinary hunting grounds, the requirement for maintaining the fixed standardized stock is observed in most cases, whereas this is not the case with the sex ratio, 1 : 1, and the present stocks show, largely, an appreciable excess of females.

Although idividual populations of roe deer often are of unequal quality, another reason for the breeding failure is to be looked for primarily in insufficient variability of the grazing available to the animals, in which this species is very particular. Poor genetic foundation of some populations occurs in quite extra ordinary instances. This has been confirmed most recently with the populations of field roe deer which, due to the improved nutritive conditions, show indications of superiority over the stocks in forests, both in weight and the development of trophies.

The Wild Boar

During the twenty years past, wild boar has expanded in Czechoslovakia to an extraordinary extent. According to legal standards that were operative before in the sector of game management, the raising of wild boar in the open was allowed only in the territory of the present Slovak Socialist Republic, whereas in that of the Czech Socialist Republic this mode of its rearing was strictly prohibited owing to the serious damage caused to agricultural stands. As a result, the rearing of wild boar was confined to enclosures only.

The operations of war and the movements of armies brought about uncontrollable leakage of this game species from enclosures to free hunting grounds. At first, the trend to expansion of its stocks was inconspicuous; later this trend became ever-increasing, so that at present the species occurs either as a steady or unsteady (migratory) element in the great part of Czechoslovak hunting grounds. Socialist game management sees to it that the wild boar continues abiding Czechoslovak hunting grounds as a common game species, but its stocks must not exceed the limits acceptable to agriculture.

Lesser stocks of the wild boar can also be found in enclosures. Since it is intolerant to other game species, the custom has been to keep it separately, in smaller parts of the enclosures. On the whole, the individuals kept under enclosure are, as a rule, inferior in vigour to those living free.

For the years to come it is suggested to establish regions of wild-boar free rearing, in such localities where existence of this game species will prove compatible with the interests of agriculture. It is further intended to develop and implement expedient principles of rearing for the regions.

The Hare

The hare is by far the most widely distributed and abundant game species of Czechoslovak hunting grounds, and it can be found represented more or less in all of them. Especially the productive field, or the largely field hunting grounds of the lower elevations, where typical hare-rearing husbandry is practised, have become known due to the high kills of hare obtained on collective hare-huntings. Bags counting several hundreds of hares are a current phenomenon, and even kills exceeding far the limit of one thousand hares per day are no exception. On more elevated hillocks and hillfoot situation the hare occurs in lesser numbers, and at elevations over 700 m its occurrence is but sporadic.

Factual stocks of hare in 1973 revealed a total of 1,448.945 head, which was 99 per cent of the standardized stock fixed at 1,454.616 head. Planned rearing of this game species gives relatively accurate results. When the standardized stocks are observed, even the occasional damage caused by hares to agricultural and silvicultural stands is tolerable. The most productive hunting grounds, where larger accumulations of hare occur, are occasionally threatened by certain epidemic diseases. Thus, during the period following World War II, tularemia has been primarily the case. This disease is under strict control of veterinaries and precautions are taken in due time to its suppression.

For the years to come, further moderate intensification of hare rearing is expected, which may be utilized better than before, even for exporting live animals to foreign countries .

The Partridge

Roughly during the past twenty years the partridge stocks in Czechoslovakia have been indicating a relatively strong trend downward. This phenomenon, which has been evident not only in Czechoslovakia but also in all other countries of Central Europe, consists of a whole complex of causes that are connected, among other things, also with the process of conversion in which the previously predominating small-scale system of farming grades into the large-scale method of production operating on large areas and applying the rational approach in all respects. It is not only the large field units under individual agricultural crops that do not answer to the partridge habit; also the high level of mechanization used in agricultural, large-scale production and the application of chemicals mean adverse effects. All that together with the other adverse agents has doubtless brought about decrease in the partridge stocks.

The census made in the spring of 1973 indicated the factual stock of partridge as 1,115.884 individuals, which was but 65 per cent of the standardized stock fixed at 1,724.335 individuals.

Eery effort has been made among the large collectives of sportsmen-hunters to improve the sad conditions as outlined above. The assitance by farmers, who are fully aware of the great usefulness the partridge means for agriculture, is highly valuable within this trend, too.

The Pheasant

Compared to the above results in the partridge rearing, situation in the sector of pheasant rearing shows the opposite trend. During the ten past years approximately, the stocks of pheasants in Czechoslovakia have more than doubled and this upward trend continues. Results of the 1973 census indicated the factual stock as 1,354.215 birds, which meant 128 per cent of the standardized stock fixed at 1,053.625 birds.

Most of the present pheasant stocks are found in ordinary hunting grounds controlled by the hunting associations. The most productive pheasant hunting grounds extend in the lowlands. It is noticable that even the trials have proved successful with introducing pheasant to the higher, hillfoot situations, roughly up to elevations of 600 m, where the bird gets gradually acclimatized to more adverse climatic conditions. The extraordinary interest shown by the greater part of the hunting associations in the furtherance of pheasant rearing has brought valuable experience and good results also under the conditions of small-scale intensive rearing, primarily when applying the form of half-wild rearing; the main object of this form being to save pheasant eggs from the nests that have been uncovered and dislocated in cutting the field crop or otherwise endangered in free hunting grounds, and to rear by artificial methods the birds hatched from the eggs thus saved. These birds are then released into the hunting ground.

The method of tame pheasant raising with the use of a breeding covey is practised in pheasantries. Most of these pheasantries are under management of the State Forests, the remaining portion is controlled by the associations of hunters. Level of this kind of pheasant rearing, which is intensive in essence, is largely high in all respects, and the stocks offer changes for large kills that not infrequently attain as much as several thousands of birds bagged on one single day.

The Other Game Species

Besides the major game species discussed in previous chapters, whose raising means the chief factor of game production in Czechoslovakia, there are also many other, less represented species in Czechoslovak hunting grounds. The most important of them have been included in Table II.

Capercailzie, heath cock, hazel grouse, and bustard are classed with the group of rare game species here.

The stocks of capercailzies and heath cocks in Czechoslovak hunting grounds have been slightly decreasing over the period following World War II. The chief reason is seen in that the bird species have recently been exposed, in their natural biotopes, to disturbing effects resulting from the higher rates of visits in the forest stands and from other changes in the environment natural to these game species. In the case of the heath cock, impact of these agents becomes often integrated by modifications in the landscape's economic character, as a result of the extensive land improvement works carried out in the landscape and, consequently, the more intensive utilization of the soil. The stocks of hazel grouse likewise show the trend to decreasing, the reason being the same as with heath cocks. Slightly higher stocks of all the three game species are still found in hunting grounds of the Slovak Socialist Republic.

The bustard stocks, on the other hand, indicate a slight upward trend in the slow process. Moreover, this bird species reveals the trend to spread westernly from its original localities. Until recently, the bustard used to be the permanent game species of the flat hunting grounds in southern Slovakia; at present, the species has already become resident in some field hunting grounds of southern Moravia. The existing system of large-area farming completely answers to the habit of this rare game species.

The rare game species of the family of hoofed animals are kept here both in enclosures and free hunting grounds. Concerning the species kept in enclosures: the bezoar goat is to be mentioned in the first place, occurring as one single population in the Pálava Hills enclosure (southern Moravia). Its unique position in the world is that locality lies most to the north among those where this game species occurs. There is another rarity of international importance, the unique population of white stags kept in the Žehušice enclosure (Central Bohemia) and counting about 40 head. — American deer is kept here in enclosures, and so is Sika deer which, unlike the former, occurs also in free hunting grounds, mainly in western Bohemia.

Special notice is due to the rearing of chamois. Until recently, this rare game species could be found in free hunting grounds of three Czechoslovak localities only; specifically, in the High Tatras (Slovak Socialist Republic) — the original home of chamois, and in the Jeseníky and Lužické Mountain Ranges (Czech Socialist Republic) to where the species was introduced several tens of years ago. Unfortunately, the conditions of life for chamois, its natural environment features an ever-increasing trend to aggravation in all of the three localities, the reason being the same as pointed to above — the growing rate of visits to the localities and the disturbances resulting therefrom for animals. To improve the situation, another two localities have been selected in the Slovak Socialist Republic; one in the Low Tatras and the other in the Large Fatra Range. Either of them is expected to offer the animals the relatively highest degree of rest. New chamois populations coming from the High Tatra locality have already been introduced, and the results obtained so far are highly promissing.

IV. Review of the utility game hunting in Czechoslovakia

Game species	Annual average 1961—65	Annual average 1966—70	1971	1972	Annual average 1961—72	Annual average 1925—29
	Kills					
Red deer	14.551	14.979	15.049	15.081	14.815	3.816
Fallow dear	1.432	1.606	1.720	1.652	1.547	1.522
Moufflon	1.090	1.316	1.679	1.832	1.295	93
Roe deer	69.741	80.217	79.760	89.869	76.202	27.846
Wild boar	5.615	6.795	8.852	10.507	6.784	1.462
Hare	772.574	1,155.174	1,353.303	1,288.398	1,023.371	901.953
Partridge	—	78.451	70.952	34.864	71.153	689.256
Pheasant	418.187	935.136	1,173.775	1,133.514	756.159	152.513
Capercailzie	—	151	187	141	155	715+
Heath cock	—	604	759	635	631	3.028+
Wild goose	—	1.748	3.511	2.329	2.083	6.118
Wild duck	51.162	115.320	139.515	126.444	91.718	35.353

Note: In column 'Annual average 1925—1929' are the data with + (capercailzie and heath cock) given only for interval 1927—1929.

References: For 1961—1965: Zásměta V.: Myslivost ve třetí pětiletce. In Czech. Lesnický časopis 13, 1967, No. 8: 677—690
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Separately for 1971, 1972: Výkaz Mysl (MZVž-ČSR) 1-01 na rok 1971, 1972. In Czech. Výkaz Poľov (MPV-SSR) 1-01 za rok 1971, 1972. In Slovak.
For 1925—1929: Štěrba M., Toupal J.: Vývoj lesního hospodářství a spotřeby dřeva v ČSR. In Czech. Praha, 1960

V. Review of the noxious game hunting in Czechoslovakia

Game species	Annual average 1961–65	Annual average 1966–70	1971	1972	Annual average 1961–72	Annual average 1925–29
	Kills					
Fox	44.323	34.296	32.060	30.533	37.974	11.833
Badger	2.193	1.983	1.545	1.337	1.980	1.255
Marten	6.075	6.232	5.731	5.010	6.023	2.875
Otter	23	–	–	–	–	324
Nyctereutes procyonoidaes	–	13	14	10	12	–
Polecat	19.794	23.456	24.504	19.902	21.721	11.678
Ermine	10.137	15.978	9.584	10.162	12.527	1.523+
Other weasel	47.075	46.801	52.675	49.567	47.635	30.637+
Muskrat	19.816	–	2.415	1.971	–	14.284
Squirrel	1.003	707	354	478	782	80.937

Note: In column 'Annual average 1925–1929' are the data with+ (ermine and other weasel) given only for interval 1927–1929.

References: For 1961–1965: Zásměta V.: Myslivost ve třetí pětiletce. In Czech. Lesnický časopis 13, 1967, No. 8: 677–690

For 1966–1970: Zásměta V., Švarc J.: Myslivost v pětiletce 1966–1970. In Czech. Lesnický časopis 18, 1972, No. 10: 943–954

Separately for 1971, 1972: Výkaz Mysl (MZVž-ČSR) 1-01 za rok 1971, 1972. In Czech. Výkaz Poľov (MPV-SSR) 1-01 za rok 1971, 1972. In Slovak.

For 1925–1929: Štěrba M., Toupal J.: Vývoj lesního hospodářství a spotřeby dřeva v ČSR. In Czech. Praha, 1960

VI. Review of the rare game hunting in Czechoslovakia

Game species	Annual average 1961–65	Annual average 1966–70	1971	1972	Annual average 1961–72	Annual average 1927–29
	Kills					
Sika deer	–	363	489	453	397	–
American deer	–	12	21	2	12	–
Chamois	6	6	7	6	6	19
Bezoar goat	–	1	–	–	–	–
Bear	5	11	16	15	9	14
Lynx	95	99	109	92	97	14
Wolf	44	43	22	40	41	4
Wild cat	553	1.053	848	788	805	378

References: For 1961–1965: Zásměta V.: Myslivost ve třetí pětiletce. In Czech. Lesnický časopis 13, 1967, No. 8: 677–690

For 1966–1970: Zásměta V., Švarc J.: Myslivost v pětiletce 1966–1970. In Czech. Lesnický časopis 18, 1972, No. 10: 943–954

Separately for 1971, 1972: Výkaz Mysl (MZVž-ČSR) 1-01 za rok 1971, 1972. In Czech. Výkaz Poľov (MPV-SSR) 1-01 za rok 1971, 1972. In Slovak.

For 1925–1929: Štěrba M., Toupal J.: Vývoj lesního hospodářství a spotřeby dřeva v ČSR. In Czech. Praha, 1960

The Slovak Socialist Republic is also one of the few countries of Central Europe where some species of the large predatory animals have survived and are kept outside confinement. These are: bear, wolf, lynx and wild cat. The stocks of bear show a slight trend to rising bear hunting is permitted only in specially justified cases. The stocks of wolves, lynxes, and wild cats must be controlled by killing if the predators endanger too much those of utility game species, the red and roe deer in particular.

GAME HUNTING IN CZECHOSLOVAKIA

The hunting and shooting of game in Czechoslovak hunting grounds follows a definite schedule made up beforehand and approved by the respective District National Committee. The in-seasons for individual game species, the modes of hunting, and the out-of-seasons are fixed by the Ministry of Agriculture and Foodstuffs in respective national republic. In co-operation with the other organs concerned the Ministries are to see to it that continuation of all game species in Nature is maintained.

From the data in Table IV will be evident the development of hunting utility game species in Czechoslovakia over periods 1925—1929, 1961—1965, and 1966—1970 in annual averages, further over 1961—1972 in a wider average, and separately for the last two years 1971 and 1972. The same mode of presentation is used in Table V for the development of hunting noxious game species, and again in Table VI for that of hunting rare game species.

The Utility Game Species

A longterm upward trend in the hunting is evident for most of the major utility game species (moufflon, roe deer, hare, pheasant); in fallow deer as a typical park deer the numbers of bagged animals reveal a stabilized pattern; in patridge and other rare feathered game species may be stated a longterm decline in the numbers of kills; while with red deer there is a typical increase in the numbers of bagged animals during the years following World War II, compared to the counts recorded for years between the two World Wars. In general may be stated that the planned game management in Czechoslovakia and the assiduous and skilled care of game by large collectives of sportsmen-hunters have already brought remarkable results, also in the numbers of kills with individual game species.

Shooting is the chief mode of hunting game in Czechoslovakia. Moreover, live game is also trapped to be used for stocking and as export material to foreign countries. The trapping of game is relatively slight with hoofed species; with hare, partridge, and pheasant, on the other hand, it is more important, as may be evident from Table VII.

The Noxious Game Species

With the exception of squirrel, the noxious game species in this country reveal evident and appreciable increases in the numbers of kills during the period following World War II, compared to situation during the pre-war period. To some extent, these increases in stocks of the noxious game species are analo-

VII. Results of Live Game Trapping

Game species	Annual average 1961—65	Annual average 1966—70	1971	1972	Annual average 1961—72
Hare	49.741	39.431	59.720	47.712	46.108
Partridge	43.630	23.219	21.131	7.185	30.213
Pheasant	59.223	48.982	58.981	58.106	54.903

References: For 1961—1965: Zásměta V.: Myslivost ve třetí pětiletce. In Czech. Lesnický časopis 13, 1967, No. 8: 677—690
For 1966—1970: Zásměta V., Švarc J.: Myslivost v pětiletce 1966—1970. In Czech. Lesnický časopis 18, 1972, No. 10: 943—954
Separately for 1971, 1972: Výkaz Mysl (MZVž-ČSR) (1-01) za rok 1971, 1972. In Czech. Výkaz Poľov (MPV-SSR) 1-01 za rok 1971, 1972. In Slovak.

gous to those observed in stocks of the utility game species. To elucidate the data in Tab. V is to be added that otter is out of season the whole year round and has been so for a longer period of time, the aim being gradual rise of its stocks. Muskrat hunting has declined because shooting this species is prohibited; it may be only trapped in nets or leather-bags. Raccoon is no home species in Czechoslovakia; its occurrence here in the most recent years has been due to natural spread.

The Rare Game Species

Most of the rare game species listed in Table VI are hunted in exceptional cases only, to serve the scientific, research and, when necessary, representative aims. Lynx, wolf, and wild cat are hunted as normal noxious animals.

THE SOCIAL TRADE HUNTING ORGANIZATIONS

In Czechoslovakia there are two social trade organisations of sportsmen-hunters; the Czech Hunting Union (for the Czech Socialist Republic) and the Slovak Hunting Union (for the Slovak Socialist Republic). In these two organizations have been associated all Czechoslovak citizens who exercise the right of game management, further all cynologists and falconers, these two categories admitted for membership as exceptions by the Central Committee of either Hunting Union.

There are altogether 121.000 members in the Czech Hunting Union and 33.500 members in the Slovak Hunting Union. Socialist character of the game management in Czechoslovakia is reflected also in social structure of the members: about 40 % are workers, 20 % farmers, 10 % employees of forestry organizations, and 30 % other professions (clerks, employees of armed forces, and the like).

SUMMARY

During the period following 1948, Czechoslovak game management has experienced significant results in all respects, due to the effective help rendered by the Communist Party of Czechoslovakia and the Czechoslovak Government. The position of game management in the socialist society has been defined by Law No. 23/1962 Sb. (Law Gazette) on Game Management and by due provisions in execution of it. The central control over game management in Czechoslovakia is due to pertinent Ministries of Agriculture and Foodstuffs in individual republics; while in the regions and districts, game management is under the control of the Regional and District National Committees.

The stocks of game species in the hunting grounds have been standardized to meet the carrying capacities of respective hunting grounds for individual major game species. The production expressed in the level of kills shows a steady upward trend with most utility game species. This trend is most conspicuous with the pheasant. Moreover, the care given to the game species with rare occurrence in Czechoslovakia and to animals that live free in nature is far from negligible.

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CHOV ZVĚŘE A JEHO VÝSLEDKY V ČESKOSLOVENSKÉ SOCIALISTICKÉ REPUBLICE

Myslivost v Československé socialistické republice dosáhla po roce 1948 za účinné pomoci Komunistické strany Československa a vlády ČSSR po všech stránkách pronikavých úspěchů. Její místo v socialistické společnosti je dáno zákonem č. 23/1962 Sb. o myslivosti a prováděcími předpisy k němu. Ústřední řízení myslivosti v ČSSR přísluší ministerstvům zemědělství a výživy České a Slovenské socialistické republiky. V krajích a okresech je myslivost řízena krajskými a okresními národními výbory.

Po stránce výzkumné a vědecké je problematika myslivosti v ČSSR řešena na pracovištích Výzkumného ústavu lesního hospodářství a myslivosti ve Zbraslavi--Strnadech, Výskumného ústavu lesného hospodárstva vo Zvolene, Státního veterinárního ústavu pro lovnou zvěř v Jihlavě, dále na lesnické fakultě Vysoké školy zemědělské v Brně, na Lesníckej fakulte Vysokej školy lesníckej a drevárskej vo Zvolene a na dalších vysokých školách zemědělských a veterinárních.

V pětilece 1971 až 1975 je ve schváleném státním plánu výzkumu řešena na úseku chovu zvěře a jeho ekonomiky problematika Biologie chovu a chorob zvěře a ochrana proti škodám zvěří, rozdělená do šesti úkolů a 35 dílčích výzkumných úkolů, které řeší kolektivy výzkumných pracovníků a jednotlivci výše uvedených pracovišť.

Kmenové stavy zvěře jsou v honitbách normovány podle úživnosti honitby pro jednotlivé hlavní druhy zvěře. U většiny druhů užitkové zvěře se myslivecká produkce trvale zvyšuje. Nejvýraznější je tento vzestup u bažantů. Významná péče je věnována i vzácně se vyskytujícím druhům zvěře a zvířat volně v přírodě žijících.

Prof. Ing. Vítězslav Z á s m ě t a, Ing. Jaroslav Š v a r c, lesnická fakulta VŠZ, Brno

THE RADIO CONTROL OF TRACTOR WINCHES IN SKIDDING

Because of relatively complicated regeneration methods, the cable extraction has a great importance in Czechoslovakia, especially in Czech lands. Apart from the continuously increasing significance of special forestry tractors amounting to about 200 vehicles in ČSR only, they are especially Z 5511 and the subsequent Z 6718 tractors equipped with radio-controlled winch TNP-1, which are becoming in favour. Since 1970, their application has achieved a surprising rise, this being documented by a number of 500 radio-controlled tractors up to 1974. It is understood that this rise has brought about several problems of organizational and production character, but their convenient solution has promoted their development at the same time. So, for instance, the Ministry of Forests and Waters together with the enterprise, which assembles and delivers these tractors — SLPV Chrudim — established a simple, but on high level organized territory plan, within which the radio-controlled tractors equipped with one of 15 possible frequencies may move without any risk that the winches will be brought into activity at an undesirable moment. The use of these devices is based on appropriate instructions and rules. The good repairing service of the firm TESLA Pardubice, which produces and repairs the radio sets, has also well deserved of this success.

The Z 5511 tractors are applied both in final and intermediate fellings. They are used particularly in the cases when the special forestry tractors are not effective, i. e. in incidental fellings made on small areas and, especially, in thinnings. In some enterprises, these tractors brought about a fundamental turn in skidding of wood obtained from intermediate fellings. The technology applied in the forest enterprise Rájec,

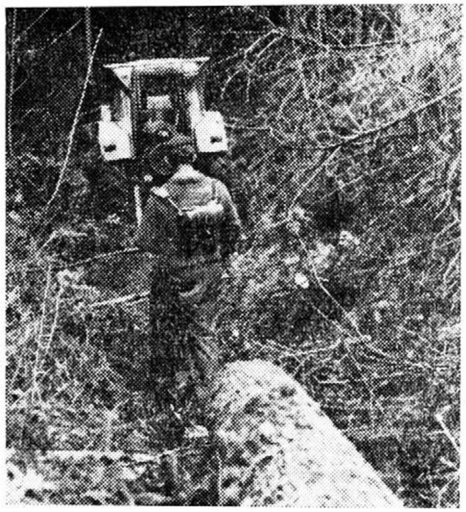
1. Unloading of timber by Z 5511 tractor in a log depot. — Traktor Z 5511 při rampování dřeva na skládce

where operate three-man crews, may serve as an example. Two members of this crew fell and trim the trees, and the tractor driver controls the winch by means of radio station and ensures wood extraction to the lines with space 25—30 m.

The extracted wood is skidded to the log depots and thereafter transported by skidding vehicles equipped with hydraulic grapple to landings where the raw logs are converted. The outputs of 3-man group, including the timber delivery to forest depot, amount to about 18—20 cu. m per day within volume rates 0,10—0,15 cu. m. The extract of time standard in hours per 1 cu. m, by which the tractor operators are renumerated, gives evidence how intensively the productiveness of skidding is influenced by radio control (table I).

This outline gives evidence that the economic productiveness of one-man crew equipped with a radio station is by 35 % higher than that of two-man crew.

The Z 5511 tractor is equipped with a front unloading device, which makes it



2. Tractor operator, equipped with the Lesana radio station, controls log extraction by winch cable. — Řidič s vysílací stanicí Lesana řídí vyklizování lanem navijáku

I.

Crew	Skidding distance m	Volume in cu. m							
		up to 0.19	0.20 0.49	0.50 0.99	1.00 more	up to 0.19	0.20 0.49	0.50 0.99	1.00 more
		soft coniferous and broadleaved wood				hard broadleaved wood			
one-man	401	0.44	0.31	0.26	0.20	0.66	0.50	0.41	0.31
two-man	500	0.68	0.47	0.40	0.31	1.01	0.77	0.63	0.48
one-man	801	0.55	0.40	0.34	0.28	0.88	0.68	0.57	0.46
two-man	900	0.84	0.61	0.52	0.43	1.35	1.05	0.88	0.71

possible to pile rapidly timber to heaps.

The proper winch control is very simple; it is based on the electro-pneumatic principle, it is to a great degree trouble-free and the appropriate Czechoslovak patent was granted to the workers of the Research Station Křtiny.

The radio set Lesana VAW 010 is composed of all-transistor receiver on the tractor and transmitter (weight 2 kg) carried by tractor operator in a knapsack.

From the safety point of view, it is necessary that another person works within sight, so that the work in crews is very convenient.

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NOVOTNÝ M., NOVOTNÝ V., RUPRICH J., VICENA I.: ELEMENTS OF OPTIMUM DECISION – MAKING IN FORESTRY PRACTICE. 1973, PRAGUE

This publication appears in the book market within the period when the introduction of new machinery and chemization and herewith connecting decision-making on their optimum use in planning and organization of technological procedures requires to abandon the traditional subjective approach to decision-making in the field of production management based on experience and, further, to accept the methods of scientific programming as a basis in the decision-making and production management.

A brief outline of optimum decision--making, management theory and methods of operation analysis as an instrument of optimum decision-making is given in chapters 2. and 3. covering 96 pages of this publication. They include explanation of basic terms and principles as plausible prerequisites for the applicability of calculation results and, further, they demonstrate that the complicated calculations must not discourage forestry practice from the application of the operations analysis methods, because the computer technique is able to cope with the complexity of calculations but it requires, as a rule, a team work. The explanation is illustrated by verbal characteristiques of outputs, quantities and their symbols in the mathematical, graphical, table and figure forms. This methodological apparatus is applied in the explanation of individual methods of operations analysis, and the model block diagrams and the simple computer operations (see e. g. the simplex method on p. 56) create in this way a useful basis and approach to the chapter 4. of the publication, i. e. to practical applications of the optimum decision-making in forestry.

This chapter also contains, on 96 pages, analyses and discussions (illustrated by practical samples of calculations) of the most topical problems of forest operations: planning of operational programs, planning and lay-out of investments, and optimum control and planning of production activities.

The part dealing with planning of production programs presents and solves some examples concerning the analysis o the optimum character of production plan and the optimization of logging program of forest enterprise. The part dealing with planning and lay-out of investments gives the methods and calculations for the dislocation of landings of forest enterprises, for the determination of log depot capacity in feeding landings with timber for the most suitable combination of conversion lines, for the determination of the number of transwerse loaders necessary for loading, and for the optimum equipment of enterprises with skidders. The part concerning the operative control and planning of production activity includes examples of methods and calculations necessary for the control of timber transport within forest enterprise, for the construction of operative plan of time control of logging operations, for the allocation of capacities to machines applied in forestry and for the choice of suitable technologies, further for the optimization of manpower number in timber loading to waggons and, finally, for the assessment of probable time losses in timber transport by lorries. Some of the above mentioned methods (e. g. the simplex method) may be also applied for the solution of other designs than those given as examples in the publication (e. g. for the solution of economical concentration and lay-out of forest nurseries, for the manpower optimization in nursery operations etc.).

All examples given by the authors are based on the concrete natural quantities, simplified for facilitating the calculations. This makes it possible that the production controlling officers both in forest enterprises and specialized centres may cope with these methods in general, as well as in the preparation of input data for their processing by computer.

The introductory part of the last chapter is of great importance both for the whole forestry practice and, especially, for the officers who, at different management levels, make decisions at what time the modern economic-mathematical methods may be successfuly applied in forestry practice.

The subsequent parts of this last chapter summarize the general principles governing the procedures in the application of the methods concerning optimum decision-making in the control practice and draw attention to some difficulties which may arise. Preference is given to the very serious questions joint with the formulation of problems and the procedures applied in their solution. This chapter is finished by the outline of some problems connecting with the definition of factors significant for the optimization, by the suggestion in which way the numeric data should be acquired and processed for the construction of a model, as well as which procedure should be chosen in team work during the application of the methods of operations analysis.

The content of publication and the form of explanation destined particularly for the workers in forestry practice will be certainly welcomed not only because the collective of authors is widely known by their useful work in the field of forestry economics, management and practice, but also because the difficult problems are described in a form comprehensible even for the forestry practicians without any detriment to the scientific level of this publication. It should therefore serve as a ready and comprehensive source of reference and as a manual to those who are responsible not only for the forestry practice control, but also for their optimum decision-making.

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