International Science Group
ISG-KONF.COM

SCIENTIFIC BASES OF AGRICULTURE, DEVELOPMENT OF WAYS OF ITS EFFECTIVE DEVELOPMENT

Collective monograph

ISBN 978-1-68564-502-1
DOI 10.46299/ISG.2022.MONO.AGRO.1
BOSTON(USA)-2022

ISBN – 978-1-68564-502-1
DOI – 10.46299/ISG.2022.MONO.AGRO.1

Scientific bases of agriculture, development of ways of its effective development

Collective monograph

Boston 2022

Library of Congress Cataloging-in-Publication Data

ISBN – 978-1-68564-502-1
DOI – 10.46299/ISG.2022.MONO.AGRO.1

Authors – Gryshchenko V., Bilokur D., Mintser O., Pesotskaya L., Glukhova N., Shchukina O., Папченко В., Матвєєва Т., Matusiak M., Vargatiuk O., Ключка С., Чемерис І., Stoliarchuk N., Dyudyaeva O., Kordzaia N., Tobółka M., Dylewski Ł., Вінюков О., Бондарева О., Чугрій Г., Коноваленко Л., Kliuchevych M., Stoliar S., Гамаюнова В., Хоненко Л., Корхова М., Смірнова І., Гончаровська І., Кузнецов В., Антонюк Г., Кецкало В.В.

Published by Primedia eLaunch
https://primediaelaunch.com/

Collection of scientific articles published is the scientific and practical publication, which contains scientific articles of students, graduate students, Candidates and Doctors of Sciences, research workers and practitioners from Europe and Ukraine. The articles contain the study, reflecting the processes and changes in the structure of modern science.

The recommended citation for this publication is:
Scientific bases of agriculture, development of ways of its effective development: collective monograph / Gryshchenko V., Bilokur D. – etc. – International Science Group. – Boston : Primedia eLaunch, 2022. 197 p. Available at : DOI – 10.46299/ISG.2022.MONO.AGRO.1

TABLE OF CONTENTS

SECTION 3. FORESTRY

10.46299/ISG.2022.MONO.AGRO.1.3.1

3.1 Peculiarities of application of environmentally- friendly main-use felling systems in conditions of central podillia

3.1.1.1 Problems and prospects of application of ecologically-oriented systems of main-use and other types of fellings

The main requirements of the laws of nature management are to ensure the functional integrity and optimal ratio of components in natural and natural-anthropogenic systems, as well as the maximum conservation of biogeocenotic covering, biological and landscape diversity. In case of these requirementsviolation, natural ecosystems loose their reliability – the ability of the ecosystem (landscape) to exist without abrupt changes in structure and functions, as well as to undergo relatively complete self-regulation and self-restoration.

In one respect, main-use felling is one of the most important stagesin forestry production, and in the other, it has the greatest impact on forest ecosystems. Ukraine has a tradition of intensive forestry practice through creation of forest plantations, the use of care felling system and widespread introduction of clear cuttings as the most economical method of timber extraction.

It should be noted that in the past the issue of reforestation was quite controversial. In particular, most scientists in the former Soviet Union were inclined to believe that creation of forest plantations was the best method of reforestation. However, today the issue of natural regeneration of forest stands comes to the fore. This is due to the fact that natural restoration of stands is the main method of preserving the gene pool for the future generations of forests. Thus, the method of natural regeneration of stands allows preserving genetic diversity of the main forest-forming tree species. Another important element is preservation of the forest environment during the uniform-gradual or group-selective fellings of the main use. This contributes to the preservation of biodiversity of the forest ecosystems as a whole. Therefore, today, the issue of introduction of gradual and selective systems of felling of the main use seems to be one of the most relevant and requires appropriate research.

In scientific sources and in practical activity, gradual felling is denoted by different names: gradual, seed-cutting, gradual-seed one. This type of felling is widely practiced in European countries. It gives the best results in oak and beech forests. The size of the felled areas makes up from 50-51 % to 55-60 % of the total area of the forest. As a result of its proper implementation over the past 25-30 years, more than 110,000 hectares of young oak, beech and coniferous plantations have been created in a natural way. In some pine and other types of forests, where natural regeneration process is not going well, this type of felling leads to excessive thinning of plantations [58].

Historically,a prototype of modern uniform-gradual felling, according to most literature sources, is a seed-cutting four-step felling, which was first carried out in the late XVIII century in beech forests of Germany and was kept as a classic subtype of the uniform-gradual felling. It consists of four consecutive stages, characterized by a specific purpose, objectives, mode of felling, timing: preparatory, seed, clearing, final, or cleaning felling. In general, felling was carried out in 4 steps during one age class [62].

At gradual fellings stands are being completely cut down within 5-40 years in 2, 3, 4 and more stages. In the process of felling, a new generation of forest appears and forms.

Gradual fellings emerged in Germany in the late eighteenth century as a counterbalance to the solid ones. G.L. Hartig substantiated his 10 «general» rules of gradual felling. Since Hartig was a supporter of a very careful intervention of felling in the stands, such felling was called «dark», i.e. the one that not too much disrupt the tree canopy.

Later, the German forester H. Cotta proposed more active fellings, which became known as «clear». Another German forester Pfeil replaced Gartig and Cotta's rules with his own ones, which were reduced to the principle of felling «everything according to the circumstances», i.e. everything was to be decided by the forester [72].

Gradual fellings had shown themselves well in mountain beech forests. The purpose of felling may be different. In some cases – more or less uniform in the area of felling, in others – in groups of greater or lesser size. This explains the name of the felling – uniform and uneven, hollow – when cutting large groups, as instead of the «window» a «hollow» is formed in the canopy.

Fellings are also divided into short-term – if it is carried out for no more than 20 years, and long-term – if more than 20 years.

The following organizational and technical indicators are set for the gradual felling: the number of felling steps; the share of stock that is taken in each of the steps; intervals between steps – waiting periods; total felling period or restoration time; the character of felling of trees on the area – uniform or uneven.

Classic uniform-gradual fellings, proposed by H.L. Hartig in the late XVIII century, provided 4 stages: preparatory, sowing, clearing and cleaning. Currently in the first stage of felling technological preparation of the area of felling is carried out aimed at the more efficient application of mechanisms and vehicles. In practice, simplified gradual fellings are more often used [74].

Through preparatory felling stands are prepared for abundant fruiting, when favorable conditions for germination of fallen seeds are created. As a result of thinning the canopy of the stand, the left trees receive more light and heat, the inflow of heat and light to the soil under the canopy increases, the processes of decomposition of the accumulated leaf litter are accelerated. Due to the small tree thinning and moderate increase in air flows, the wind resistance of the stand rises. Fout, overripe, weakened, broad-crowned, as well as less productive deciduous trees (in coniferous-deciduous stands) should be cut down.

Seed felling is carried out in 4-5 years after the preparatory one, during which up to 25-30 % of the stand is cut down. By this time, the thinned stand begins to bear fruit, seedlings and undergrowth appear, which occupy free space and prevent the spread of aboveground vegetation. The main task of this step is to create favorable conditions for the emergence of seedlings and undergrowth. Therefore, seed felling is timed to the years with good fruiting (seed year). Trees with high crowns are left on the vine. The tree crown densityof the stand canopy is adjusted to an average of 0.5-0.6, depending on the natural zone conditions and varietal composition. In the northern regions it may be lower (up to 0.4), and in the south – higher (up to 0.7). For pine trees regeneration, the crown cover may be lower (0.4-0.6), for oak, spruce and beech – more than 0.6-0.7. More substantial thinning can cause excessive growth of competitive herbaceous vegetation and undergrowth, which significantly impairs conditions for the restoration and growth of forest-forming species.

Clearing felling is carried out 4-6 years after the seed one, when the undergrowth reaches considerable size and requires more light for its further growth. Another 25-30 % of the stand is cut down, primarily weaker and less stable trees, leaving a protective cover of more stable trees until the last step. The densityof the stand is reduced to 0.3-0.4. The rest of the trees protect the new generation from sharp fluctuations in temperature and other climatic phenomena that negatively affect the growth of the younger forest. Cleaning felling is carried out in 3-5 years after the clearing one. By this time, a 20-year-old young forest has been formed, which under favorable conditions close the crowns and can perform ecological functions [64,66].

Depending on the specific features of the site and the prevailing conditions, the presented scheme of standtransformationprocess may be changed. After the preparatory felling, regeneration may occur, and vice versa, preparatory felling together with a clearing one may not always give the desired result. Then additional techniques or additional reforestation measures are needed.

The number of steps, periods of their repetition, as well as the intensity of the first steps of felling are determined by the initial condition of plantations, their species composition, fruiting period and forest typological conditions, as well as bioecological properties of undergrowth and their age dynamics. Thus, pine undergrowth can not exist even under a thinned canopy and should be let out in few years due to the final felling. Spruce and beech undergrowth can grow satisfactorily under the canopy of the forest for decades. It is advisable to uncoverit when reaching a 1.5 m or more height.

The period of self-sown treesdevelopment under the forest canopy is accompanied not only by periodic felling of mature trees, but also by measures to promote natural regeneration, including care for young woody plants, preventing their suppression by grassy vegetation and undergrowth [65,67].

Selection of trees for felling for the initial (at a two-step felling) or the first 2-3 ones is done, generally, according to the forestry principle of voluntary sampling where firstly trees of unsatisfactory condition, less durable species (in mixed plantings), and also the largest wide-crowned and the oldest specimen that adversely affect more viable trees, which can significantly increase growth after thinning are cut. To achieve this goal, a relatively long period between steps can be set, if it does not lead to the deterioration of young generation under the forest cover. This measure can improve the quality of the harvested wood and increase its marketable value. The uniformity of trees selection depends on the specific features of the planting and varies widely – from more or less uniform, individualfelling to a group one [65,67].

Uniform-gradual fellings are carried out in forests of all groups, taking into account the specifics of their purpose in both lowland and mountain forests. This is due to the fact that the environmental consequences of such fellings are close to the voluntary-selective ones. For uniform-gradual felling the maximalparameters among all others are established: in lowland forests – up to 50 ha with reduction by 1.5-2 times in forest-steppe areas, and in mountain conditions – taking into account slopes steepness and their exposure [62,63].

Gradual felling in oak forests is justified by the following factors: the weight of oak seeds (acorns) that fall to the ground close to the maternal trees; protection of acorns that have got into the litter from drying out; possibility of growing coeval oak stand with de-knotted stems.

However, the relatively low shade tolerance of oak can lead to the transformation of self-seeding into sticks and its death under insufficiently thinned crown cover, especially due to the inherent multi-storey structure of the oak stand, which enhances shading in the forest. Strong thinning of plantings during the first phases can create unfavorable conditions for the oak as well. Therefore, the task of natural regeneration of oak stands with the use of gradual felling is quite difficult.

Depending on the climate,fruitful years and forest vegetation conditions associated with it, gradual fellings in oak groves were transformed and gave different results. Thus, in the central regions of France three-step fellings were carriedout during 15-20 years, whereas in western France, the complete restoration of oak occured in 6-10 years. In Spessart (Germany), where fruitful year occur every 10-12 years, it is much more difficult to solve this problem [71].

In our country it was decided to carry out solid fellings in oak forests. Many foresters favored such 50-100 m fellings [72]. For moist and fresh maple-linden-oak forests of the left-bank forest-steppe of Ukraine, solid fellings even up to 200 m wide were recommended [73].

Summing up the experience of the oak forests management of our country during a centennial period, A.V. Tyurin concluded that natural seed regeneration of stands in oak groves at solid fellings is possible in all forest areas except steppe one. However, the issue of gradual fellings in oak groves deserves attention as well. They were carried out in the oak groves of Chuvashia, in Ukraine (Trostyanets Forest, Black Forest), in Belarus and Georgia [69].

In 1909, the Russian forester B.Y. Guzovskiy proposed a scheme of gradual two-phase felling in oak groves. As the first step, he recommended removing minor species from the first and second sroreys, overripe and diseased trees, as the second – to thin a dense undergrowth of hazel. The scheme itself has not been widely used in practice, but it contains some valuable provisions that have not lost their significance today. One of them is a special approach to the undergrowth.Hazel plays a dual role in the existence of oak, which varies depending on the density of the undergrowth. It is necessary to periodically thin the undergrowth of hazel, but not to cut it down completely. Thinned undergrowth of hazel is good for oak, and thick is harmful. This situation should be taken into account when carrying out gradual felling in oak foreststo prevent suppression of oak by hazel [72].

You need skillful approach to the oak satellites from the second storey of the forest canopy to regulate their density. Complete removal of the second storey can lead to the formation of watery shoots in oak and other undesirable consequences.

In Belarus, gradual three-step fellings in spruce-hornbeam groves gave a generally satisfactory result, except some cases of uneven placement of oak self-seeding, which required in some places sowing in specialsites. In hornbeam groves, the correct conduction of the first stage of gradual felling ensures the emergence of a sufficient number of oak undergrowth under the forest canopy [74].

In the 50s of the XX century, for hornbeam-oak forests of Belarus, A.L.Novikov proposed no later than 5 years before the final felling to fence the felling area and in the first summer cut down all undergrowth and thin hornbeam. In the first seed year of the oak, areas for natural renewal are laid under the forest canopy. In two years after the undergrowth cutting, in winter, the second storey of the canopy is removed, which consists mainly of hornbeam and other species (maple, aspen, linden), the whole undergrowth is cut down as well. In two, and sometimes three years after the second phase the last step of felling is carried out. This option is good for the Belarus conditions, as the intervals between the seed years of oak in this case are reduced to two or three years.

For high-density stands in coniferous-oak forests (D_3) B.D. Zhilkin recommended two-step gradual felling with taking 50% of the stock, during the first step impurities and unpromising oak trees are removed [70].

Gradual felling is quite acceptable for mountain oakforests on slopes with up to 35° steepness. In the oak groves of the lower part due to the frequent seed years, the regeneration period should be reduced and carry out fellingin three steps during 10-12 years. During the gradual felling in the oak-hornbeam stands of the Tbilisi forestry, it was found that, in addition to seed regeneration, overgrowth from the stumps of the felled treesappeared, which suppresses the seedlings. Therefore for such cases it is recommended toremove the bark from the stumps in the year of felling before the vegetation period begins.

Two- and three-step gradual fellings are recommended in the oak forests of the foothills and midlands of the North Caucasus. First stage should be done in a seed year, bringing density of the stand to 0.8. On the other hand, gradual felling in the forests of the Caucasus can contribute to the development of grass cover, which prevents the regeneration of oak. In hornbeam-oak plantations, gradual felling leads to the replace of oak by hornbeam, and in pure oak groves it stops regeneration of oak.

When carrying out gradual felling in oak forests, it is necessary to pay attention to the fact that oak usually has a wide crown, strong side shoots and thick massive branches.

Analysis of gradual fellings in oak forests shows that without good care felling (clearing, cleaning, etc.) there will be no good result. Many foresters prefer solid fellings followed by subsequent regeneration. Although under certain conditions, gradual fellings have advantages over solid ones. On the flat territories of the country with frequent seed years, gradual felling is possible in many types of forests (except dry ones). In mountain oak groves gradual fellings deserve a lot of attention. As a preventive effect on the soil in oak forests during gradual fellings, in addition to loosening, it is possible to graze pigs in the forest before seed felling. Gradual fellings in oak forests can be combined with other methods of felling.

In oak forests, as well as in the forests of other species composition, the final or solid felling can be combined with the preparatory care felling. In this case, the preparatory and seed stages are carried out during care fellings, which are not finished in the ripe plantations, but are continued in the mature ones, until oak regeneration of sufficient quantity and good quality is obtained under the plantation canopy [68].

Simplified 2-3-step gradual fellings, although originated in Germany, were widely used in Russia, where they were especially promoted by D.M. Kravchinskiy, N.K. Genk. In Ukraine, Prof. E.V. Alekseiev was an active researcher of gradual fellings. He used two-stage gradual fellings in the forests of Volhynia in the early XX century and until 1917. After the first step, the pine was regenerated, and after the final one it was sometimes destroyed up to 90 % [72, 73].

Detailed generalizations of gradual fellings were made by E.V. Alekseiev in his work “Seed fellings” (1927). He believed that uniform-gradual fellings can give positive results in all types of pine woods of Polissya, except dry and fresh forests. He leaned towards three-step, and sometimes two-step fellingsand recommended to carry out felling in the presence of snow cover. E.V. Alekseiev considered pine regeneration promotion measures indispensable. But in the lowland forests of Ukraine gradual fellings did not aquire large production scales [69, 70].

At group-gradual fellings the trees are cut down only in the designated place, usually where there are groups of undergrowth. If stands are cut down in small groups (50-300 m^2), then felling is called group-selective one, at a larger area – hollow. Solid curtain fellings, in which curtains of mature and overripe trees are removed from thestands of different age, leaving the curtains of young, medieval and ripening ones, are another kind of group-gradual fellings. The number of steps and general term of removal of trees at group-gradual fellings is bigger, and intensity of felling is less, than at uniform-gradual ones. At group-selective fellings on each hectare 5-6 «windows» with undergrowth are selected. During the first step, mature trees in undergrowth groups, overripe ones, those with highly developed crowns, infected with gray cancer, sponge and other diseases in the 10-20 m wide strip around them are cut down, removing about 15 % of the total stock. This creates better conditions for the emergence and development of undergrowth. During the following stages which are performed in the next 6-10 years, mature stands in strips around the undergrowth are cut down, expanding the latter, taking away 10-20 % of the stock. The felling of the mature stand is repeated until all undergrowth groups in the area are closed, forming young stand of different ages. The number of steps and intervals between them depends on silvicultural properties of wood species, conditions of their growth, height of the stand, etc. To promote natural regeneration of photophilous species in tall stands, «windows» of large size are necessary, thus more felling steps are required. In dry climate, the number of steps should be also greater than in humid one [72, 73].

It is impossible to give an unambiguous assessment of gradual felling, because they have both positive and negative features. In the past, foresters in Russia and Ukraine were interested in fellingsin pine woods. Practice has shown that uniform-gradual felling is effective in most types of pine woods, but in most conditions a range of measures to support natural regeneration of pine is required. In lowland conditions, at a 0.8 and more densitygradual three-stage felling should be carried out and ata lower density – two-stage one. Gradual felling provides more coarse assortments, reduces reforestation and causes less soil damage from mechanisms. In general, uniform-gradual fellings have the following positive features: they allow uniform sowing of the area, even with heavy seeds; contribute to the normal course of reforestation by creating better micro-conditions; ensure preservation of protective functions of the forest; increase the yield of large assortments due to the increased illumination; reduce the time of growing mature plantations. Disadvantages of fellings: complexity of the technology of felling; damage to trees and undergrowth during felling; difficulties in carrying out felling in windfall plantations; complication of reforestation in many types of forest conditions; 20-25 % cost increase compared to the solid felling.

As it can be seen, the existing disadvantages havepurely productive character. They can be avoided. Gradual fellings, especially group-selective ones, should be used in recreational forests.

When assessing the uneven gradual fellings, their positive features should be noted. They are the following: they are better than other methods of felling consider the diversity of forest conditions in small areas and characteristics of stands; they allow taking into account various biological and ecological features of tree species in mixed stands, the biology of beech in particular; accelerate the onset of maturity of stands through the use of the previous and concomitant regeneration; ensure the preservation of water-regulating and soil-protective functions of the forest. Negatives: they complicate the use of modern machines and mechanisms; not always provide high quality wood; when the area of the groups expands, the soil surface may become turfed.

Regeneration of oak stands in the Western region of Ukraine also takes place mainly through artificial reforestation. The share of annual artificial regeneration is about 80-90% [57]. General information about the fruiting of oak in conditions of the Western region of Ukraine is presented in the works of K.B. Lositskiy [68], P.I. Molotkov [73], L. I. Copiy [57]. According to the results of research, it is found that in the best climatic and soil-hydrological conditions the yield of acorns is usually higher. According to the conducted research, the periodicity of intensive fruiting of oak is 9-10 years. Less productive years are repeated in 5-7 years [57, 59]. Studies of environmental factors that significantly affect the fruiting of oak were conducted by a significant number of scientists [57-61]. Researchers note that the intensity of fruiting is closely related to the availability of nutrients in the soil. Plants that grow in more fertile soil conditions are characterized by more intensive fruiting. The results of research indicate that the most intensive fruiting is characteristic of stands over 70 years of age with a of 0.6-0.7 density, as well as ofstands where forestry activities were carried out, in particular, care felling, felling of the main use. Analysis of the age structure of young generation of oak indicates the predominance of 3-5 year old undergrowth. The share of undergrowth over 5 years of age is insignificant. Undergrowth is mainly characteristic of the stands with sufficient illumination, which indicates the dominant role of light in the viability of undergrowth. Even moderate shading of undergrowth can lead to its deterioration and death. Further successful growth of oak depends exclusively on sufficient lighting. According to research, light level less than 15 % comparing to the open space does not ensure successful natural regeneration of oak. With intensive illumination, which is characteristic of solid fellings, natural regeneration occurs more intensively. However, due to the intensive growth of grass cover and associated species, the intensity of natural regeneration may be significantly reduced.In conditions of Podillia intensive development of grasses poses a significant threat to oak self-seeding. Especially intensive is the development of grass stands in full light conditions. Depending on the period of natural regeneration of oak stands and the age of young oak trees, its interaction with grass cover is divided into several stages: 1st –the stage of self-seeding, 2nd – survival of seedlings, 3rd – the stage of further growing [57].

In order to diagnose the growth, development and condition of self-seedlings modern physiological methods are used. In particular, the method of measuring the magnitude of biometric electric potentialsapplied by Kozlovsky, 1980, Krynytskiy, 1976, 1984, 1994 [58]. To assess the state of self-seeding, the method of accumulation of green and yellow pigments in plant leaves is widely used (Nesterovich, 1969). A study of the amount of chlorophyll and carotenoids showed that its greatest accumulation is characteristic of self-seeding, which was in the shade and had unsatisfactory condition. On felling areas, under conditions of moderate grass cover development, minimal chlorophyll content was observed in the undergrowth leaves. According to the results of regression analysis, it was found that maximal accumulation of chlorophyll at good state of natural regeneration is provided at illumination equal to 25-40 % of that of the open space. According to the results of the conducted research, it was established that the undergrowth of oak, which is characterized by a high level of bioelectric potentials, is in good condition. Analysis of research results confirms the conclusion that the main obstacle to the successful growth of oak undergrowth is the maternal stand itself [66,68].

In view of the foregoing, it becomes clear, that ensuring optimal growth and development of oak stands undergrowth is one of the main issues in preserving their biodiversity. The widespread use of solid fellings does not make it possible to restore oak stands in a naturalway due to the tough competition from grasses and shrubs. Therefore, it is advisable to introduce such methods of main use felling, which would ensure natural reproduction of stands [66, 70].

At the end of the 19th and in the middle of the 20th centuries, the first experiments on introduction of the non-solid felling of the main use in oak forests aimed at their natural regenerationwere started. Such studies were conducted in the forests of Polissia, Forest-Steppe natural zone (M.V. Romashov, 1971) and the Carpathians (P.I. Molotkov, 1966; V.A. Buzun, 1965; M.M. Gorshenin, 1963; S.A.Gensiruk, 1959, 1964) [71, 72-74]. According to the research results, non-solid types of the main use fellings have significant potential of ensuring successful natural regeneration of stands. In particular, it was found that selective and group-gradual fellings meet the nature of forests of different ages. Such fellings give positive result in uneven-aged forests with a sufficient amount of undergrowth required for the formation of new generation. However, group-gradual and group-selective fellings were not usefulin Ukraine and did not show positive effect.Group and selective fellings were most successful in Sumy region, butdespite this fact, they did not meet the relevant demands for the formation of oak stands and requiredappropriate care ofthe oak undergrowth.

3.1.1.2 Theoretical bases for the use of ecologically-oriented systems of fellings

Ecologically oriented felling systems are aimed at preserving the forest environment, stimulating the processes of natural regeneration and formation of uneven-aged stands. Such fellings are maximally close to the natural processes that occur in forest stands during their development. The stand, having reached the aging stage, begins to gradually disintegrate. Some trees in it die and fall off, freeing up space for the younger generation of the forest. Thus, for decades there has been a change of generations and a young forest is being re-formed, which inherits the best qualitiesfrom the maternal stand acquired in the specific natural and climatic conditions. This ensures conservation of species and genetic diversity,as well as formation of biologically stable forests.

In Ukraine a solid felling system is still dominates. After solid felling, the microclimatic conditions, species composition of grass vegetation, microorganisms, etc change dramatically. On thefelling areas as a rule, forest plantations with seedlings grown from seeds of various origins are immediately created. In this way, movement and mixing of genetic material occurs, the genetic structure of future stands is impaired, which can lead to a decrease in their biological stability and species diversity of forest phytocenoses. In addition, reconstruction of the forest environment in such areas begins after the closure of forest canopy, that is, after 5-10 years.

Ukraine and other countries have accumulated considerable experience in the application of gradual fellingsaimed at natural seed reproduction of native stands [72, 74]. Successful reproduction of stands depends on a number of factors, the most important of which are the intensity of seed production of tree species, the light intensity under the cover of the stand andthickness of the forest litter.

The frequency of abundant fruiting of the European oak in different parts of the distribution area is 2-10 years. The highest yield of acorns made up 2.3-2.7 t/ha [70]. It should be noted that even in non-productive yearsthere amounted from 10 to 100 thousand acorns per 1 ha under the forest canopy and this number is sufficient for good regeneration of oak [70, 71]. A large proportion of oak acorns are damaged by insect pests and phytodeseases. Consequently, in the oak groves of the western region of Ukraine only about 15-18 % of acorns are healthy. In general, damage to oak acorns in different parts of the Forest-Steppe natural zone varies between 50-99 % [70].

Forest litter is a significant barrier to the germination of seeds, especially small ones. For example, the root of a pine seedling after germination of a seed does not often reach the soil and dies. For the oak seedlings, the thickness of the forest floor is not so important. Not only soil but also light nutrition is needed to ensure the vital processes of self-seeding. Dependence on light intensity is different in different tree species. Photophilous tree species, and especially European oak, are characterized by high demands to the light regime under the cover of tree stand. The most favorable conditions for the emergence and development of oak self-seeding are under the canopy with a 0.6-0.7 density [70]. At figures above 0.7 and below 0.6 intensive oak self-seeding dying off takes place. It is obvious that at densities below 0.6, the grass cover develops intensively, which, along with the stand, creates additional screen for light penetration. Under the canopy of high-growing stands undergrowth of oak dries up and dies during the first 1-3 years [73]. In general, undergrowth of oak can survive under the cover of stands at light intensity not less than 3 % of the maximal.

Thus, natural regeneration and especially the survival of the undergrowth of oak under the cover of compound stand is not possible without forestry measures, one of which is the use of gradual or selective felling, aimed at stimulating the seed production of tree species and formation of favorable conditions for the growth of young generation of forest. During 1962-1963, an experiment was set up in Lviv Roztochchia in a pine-oak stand with the 7P3O+Scomposition, which included four methods of felling: two- and three-step uniform-gradual and three- and five-step group-selective ones [73]. Good regeneration of oak and pine was observed in the sections of uniform-gradual two- and three-stepfelling as well as at group-selective three-step felling.As of 1995, high-density stands with a 5-8 pcs share of oakand 1-5 pcs of pine were formed here. In addition to them, the stands also includedthe Norway maple and sycamore, hornbeam and linden. According to the latest data, at the age of 45, in the sections of two-step uniform-gradual felling a natural stand, and in the sections of three-step uniform-gradual and three-step group-selective felling–a derivative one with predominance of oak was formed [69]. The stock of wood in the stationary sections varies between 162-347 $m^3 \cdot ha^{-1}$. Good results demonstrate natural regeneration of the fertile pine stand with participation of the Radekhiv oak population. After the first stage of the two-step uniform-gradual felling, the number of self-seededpines was 500-700 thousand pcs $\cdot$ ha^{-1}. Another example of the use of different kinds of fellings is the natural restoration of the old age oak stand in fresh hornbeam oak grove in the Carpathians. Reforestation measures there managed to increase oak self-seeding by 1.5-4.2 times. Positive results from forest management measures were also obtained in the natural regeneration of European beech on the flat part of its distribution area. At the same time, the experiment on seed-cuting fellings carried out during 1982-1994 in the Boyarka woodland showed the impossibility of regeneration of the pine-oak stand in fresh forests.

It is obvious that for the successful natural seed regeneration of stands by conducting uniform-gradual or group-selective felling individual approach that takes into account the characteristics of stands, namely forest type, species composition and age of the stand etc is required.

3.1.1.3 Reforestation processes on the areas of solid fellings

During 2015-2017, we collected data on the natural regeneration of common oak on solid felling areas in Khmelnytskyi region. Natural regeneration of oak was observed in a number of state forest enterprises of the Khmelnytskyi Regional Department of Forestry and Hunting: Starokostiantynivske, Novoushytske, Letychivske, Yarmolynetske and Khmelnytske.

Natural seed regeneration of oak is found only in some areas. The total number of such locations within individual enterprises depends on the volume and number of solid fellings, the share of European oak in stands, the uniformity of distribution of the trees in the area, the intensity of fruiting before felling, and subsequent care of undergrowth of tree species. Data on the successful natural regeneration in the areas of solid fellings within the «Starokostiantynivske forestry» are given in Table 1.1.

Table1.1

The amount of oak undergrowth on the felling areas of different years at enterprises of the Khmelnytskyi Regional Department of Forestry and Hunting (2016)

Forestry	Quarter/Location	Area, ha	Index of the forest type	Year of felling	Average age of the undergrowth, years	Number of oak trees, thousand pcs·· ha^{-1}	H_{avg}, cm
1	2	3	4	5	6	7	8
«Starokostiantyniv Forestry»							
Samchykivske	29/2	2,2	D_2-HO	2007	8	4,0	180±35
Hrytsivske	21/1	4,4	D_3-HO	2011	4	4,5	80±15
	37/7	4,8	D_2-HO	2011	4	5,0	100±20
	50/32	0,6	D_3-HO	2010	5	5,5	90±15
	37/7	1,5	D_2-HO	2009	6	5,2	130±15
	27/11	2,8	C_3-HO	2009	6	4,5	170±30
	68/2	2,7	D_2-HO	2009	6	5,0	130±20
Krasylivske	59/9	1,1	D_2-HO	2009	6	4,0	140±35
	58/6	1,0	D_2-HO	2009	6	5,1	110±15
	82/2	0,3	D_2-HO	2008	7	4,3	100±10
	68/2	0,2	D_2-HO	2009	6	4,5	110±25
	678	0,3	D_2-HO	2009	6	4,0	130±20
«Nova Ushytsia Forestry»							
Struzke	25/36	2,9	D_2-HO	2009	5	3,0	110±25
«Yarmolyntsi Forestry»							
Vinkovetske	68/1	1,9	D_2-HO	2012	2	3,5	30±5
	68/3	1,9	D_2-HO	2008	6	2,5	150±35
«Letychiv Forestry»							
Bokhnianske	1/12	5,6	D_2-HO	2009	5	3,1	70±15
«Khmelnytskyi Forestry»							
Khmelnytske	20/13	8,8	D_2-HO	2009	5	2,8	60±10
«Kamyanets-Podilskyi Forestry»							
Maliyevetske	54/1	5,6	D_2-HO	2009	5	3,0	80±20

Note: * HO – hornbeam oakery

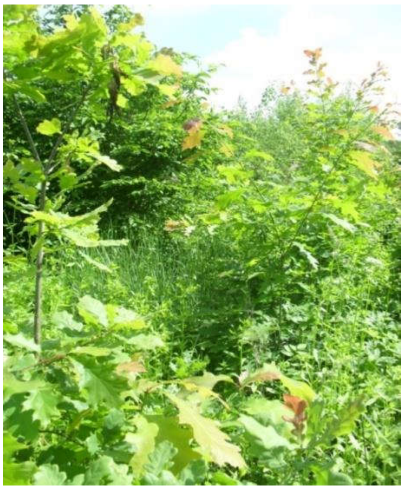
Table 1.1 shows that natural regeneration is observed mainly in fresh hornbeam forests. Only three areas with natural oak regeneration are situatedin the wet hornbeam grove.The area of lands with natural oak regeneration ranges from 0.2 ha to 8.8 ha. Most of the lands have the area1-4 hectares.

Oak undergrowth was found mostly on the felling area of 2008-2010. However, the largest number of sites with its natural regeneration was registered on the 2008 felling area. As of 2015, the average age of the undergrowth was between 4 and 8 years, with a predominance of 5-6-year-old individuals. The average number of undergrowth is 2.5-5.5 thousand pcs per hectare. With age increase, the amount of oak undergrowth decreases significantly [66].

The best oak regeneration level is observed on the felling reas of the «Starokostiantyniv Forestry», where the number of young trees varies between 4.0-5.5 thousand pcs · ha^{-1}. In other forestries, the amount of oak of natural seed origin in areas of solid fellings does not exceed 3.5 thousand pcs per hectare.

Regular tendencies to the increase of the height of oak undergrowth with its age can be traced. At the age of four, its average height is 0.8-1.0 m, at the age of 6 – it reaches 1.1-1.7 m, and at the age of 8 – 1.8 m. Fig. 1.1 illustrates the six-year undergrowth of oak on the felling area of Hrytsivske enterprise of «Starokostiantyniv Forestry».

a



b

Fig. 1.1. Six-year-old undergrowth of oak on the felling area of Hrytsivske Forestry: a – area in quarter 37, location7; b – area in quarter 27, location 11

Fig. 1.1 demonstrates that the undergrowth of oak in the felling areas is located mainly in curtains and is characterized by high growth intensity and good condition. The leaves on the trees have a bright green color [72].

In one of the areas of the Vinkivtsi forestry (felling of 2012) we found about 3.5 thousand pcs · ha^{-1} of biennial oak undergrowth averagely 0.3 m heigh [67].

Natural seed regeneration of oak in SE «Nova-Ushytsia Forestry» was successful after solid felling in 2009 on a total area of 2.9 hectares. Undergrowth of oak has a curtain character, distributed mainly around the stumps. Successful natural regeneration was conditioned by a significant proportion of oak trees in the stands before felling (9O1H). Currently, there is competition between oak undergrowth and related tree species, which indicates the need for care measures implementation.

Two areas with successful natural regeneration of oak after deforestation in 2008 and 2012 were discovered in SE «Yarmolyntsy Forestry». Before felling these areas were characterized by a significant proportion of oak trees, namely 7-9 pcs in the stand and relatively uniform distribution of trees on the area. This provided a more even spreading of the undergrowth. Along with this, natural regeneration of oak had curtain character. Undergrowth of biennial oak was characterized by dense groups and was in good condition.Its successful growth in groups and no significant competition from grasses and related tree species was observed there.

Areas with five-year-old oak undergrowth were found in SE «Khmelnytskyi Forestry» on the area of 8.8 ha and in Malievetske Forestry on the 5.6 ha area. These areas were characterized by the same type curtain distribution of oak undergrowth. For the most part, oak undergrowth was in good condition and no significant competitive influence of herbaceous vegetation and undergrowth of associated species was noticeable.

During successful natural regeneration of the European oak on a solid felling area, its curtain arrangement around the stumps of old treeswas registered. The trees left for the preservation of biological diversity are mainly of undergrowth origin, theyare hollow, what significantly reduces their viability. They mostly have a low selection value, negative for further natural regeneration of stands. Under the canopy of the left curtains of old-aged trees turfing of the soil and lack of natural regeneration was observed.

3.1.1.4 Application of the gradual and solid felling systems

All experimental and production 2- and 3-step gradual and narrow fellings according to the Kornakovskyi method were carried out from 1964 to 1970 in the «Galileia» forest land of Ulashkivka Forestry. They were aimed at natural seed reproduction of high-yielding oak stands and preservation of species and genetic diversity of forest stands of the «Galileia» forest land [67].

Experimental two-stage uniform-gradual felling was started in 1964 in quarter 60 location 4 on the area of 3.0 hectares of Ulashkiv forestry. The first storey of the stand wasrepresented by oak, the second – by hornbeam with a small admixture of maple. The age of the oak storey was 110 years, and 25-40 years – of the second storey. The average height of the oaks ranged from 28 to 30 m, the average diameter – 47-49 cm. As for the second storey, the figures, respectively, were 12-14 m and 13-18 cm. The density of storeys was 0.6 and 0.1, quality class – I. The stand had a mixed seed-undergrowth origin. The type of the forest was fresh hornbeam grove, soils – gray forest loam. The oak undergrowth was represented by 1-year-old specimens, in some places in the windows of the upper canopy it formed solid curtains. Undergrowth of hornbeam was thin, evenly distributed over the area, aged 1-10 years, theunder growth – thin, represented by dogwood, hazel and hawthorn. The area of the site and its configuration allowed laying the following variants of felling:

- 2-step gradual felling with 35 % of the stand mass cutting during the first step;
- 2-step gradual felling with removing 35 % of the mass of the stand in the first step and facilitation of natural regeneration by cutting all undergrowth species and the second storey;
- 2-step gradual felling with cutting 35 % of the mass of the stand in the first step withnatural regeneration facilitation and stuffing of acorns in rows in every 5 meters;
- the control was a variant of solid felling withoutnatural regeneration promotion measures.

The oak on the experimental areas was felled in such a way as to form a straight corridor 4 m. wide. In the future, this variant became the basis for the recommended strip-selective method in derivative stands.

Experimental variants were limited by security zones. On all variants the stationary 2x2 m accounting areas in the amount of 25 pcs per 1 ha were laid. In January-February 1965 the first step of felling was held. Measures to promote natural regeneration were not carried out due to the complete absence of acorns. In order to bring the experiment to the plan, in 1966, the following works were performed:

- in the variant, which provided for the planting in acorns in the fall of 1965, in the spring of 1966 under the thinned forest canopy through gradual fellingyoung oak forest was created by planting annual seedlings according to the 5.0 x 0.5 m pattern;
- in the variant of the experiment, which in the autumn of 1965 provided for the promotion of natural regeneration, in 1966 the soil was loosened in strips 0.5 m wide at a 5.0 m distance from each other.

The final stepof felling took place in winter,1970. Between the felling steps, the necessary work was done to study the dynamics of the undergrowth accumulation and dying off, growth of the remaining part of the stand, etc. The undergrowthcare measures werealso taken.

In 2006, an examination of felling areas was conducted. A 37-year-old stand with a 9H1O+Ch+S composition, 13 m average height, 14 cm diameter, the second class of quality, 0.78 density and 105 m^3/ha wood stock has been formed on them. The examination have shown that over the past 30 years, hornbeam had been replaced by oak and was slightly represented in stands, despite the care of its undergrowth, as well as attempts to replenish it. The use of certain methods to promote natural regeneration also did not give positive results.

Fellings by the Kornakovskyimethod were carried out in 1964 in the square 58 of the Ulashkiv Forestry on the area of 16.1 hectares. The felling wasdesigned for 9 years with the annual cutting of two areas 25 m wide and 320 m long each with a 3-year term of closure.

A two-storey stand was selected for felling. Composition of the first storey was10O, of the second – 10Gz. The age of the stand was 100 years, quality class – I. The average height of the 1st storey was 28.3 m and diameter – 54.5 cm. As for the 2nd storey, the figures were, respectively, 16.9 m and 15.9 cm. The density of the 1st storey was 0.81, and of the 2nd – 0.4. The area was situatedin a fresh hornbeam grove. The stand had a mixed seed-undergrowth origin in which the number of undergrowth specimens of oak made up about 20 %. The stand had the first marketability class.

The undergrowth of tree species was represented by a 1-year-old oaks evenly distributed throughout the area. Undergrowth of hornbeam at the age of 1-5 years was very dense and wasplaced in curtains. Young forest was thin and consisted of dogwood and viburnum. Soil was gray forest loam. The relief was flat.

In 1965, two 25x320 m areas were cut down. Given the large length of the area, it was divided into two 25x160 m each strips. One of them was cut down in winter, the other – in summer.

Both before and after the felling, the undergrowth condition was recorded at 15 permanent accounting locations. It was established that 37 % of oak undergrowth was damaged during felling in winter and 30.5 % – in summer.

In 1966, two more areas were cut down using the technology of the previous year. Besides, in 1966 an additional permanent accounting area (5x5 m) was laid on the strip, which was cut down last. This was done to compare the course of natural regeneration on the felled strips and under the stand cover. In 1966, there were 7.2 thousand pcs · ha^{-1} of three-year-old and 5.2 thousand pcs · ha^{-1} of older than 5 year-old oak undergrowth. Subsequent fellings were carried out in 1967 and 1968 with a parallel study of the number and condition of oak undergrowth.

In 2006, a study of taxonomic indicators of stands in the Kornakovskyi fellingresearch areas was conducted. Currently, these stands are located in quarter 48 (loc. 2-7, 9-17, 21-23).

The areas felled by the Kornakovskyi method border on the areas that were formed after the 1930-1935 fellings. In these areas, ash stands were mainly formedwich included 4-7 ash trees in their composition. Several areas bordering the research sites comprise spruce varietis created in recent decades.

Taxonomic indicators of stands where narrow Kornakovskyi fellings were applied are given in Table 1.

Table1.2

Taxonomic indicators of stands that were formed in the areas after the Kornakovskyi felling

Location	Area, ha	Year of felling	Stand composition	Age, years	h, m	d, cm	Quality class	Density	M, $m^3 \cdot ha^{-1}$
2	0,8	1934	4S6H+O	72	26,1	30,3	I^a	0,65	230
3*	1,6	1965	7H3S+O	41	14,3	16,4	I	0,72	114
4*	0,8	1968	9S1H	38	15,2	12,6	I^a	0,70	127
5	0,8	1934	5S5H+O	82	25,4	32,2	I	0,64	230
6*	1,6	1965	8H1O1S	46	14,2	16,6	I	0,72	112
7*	0,8	1968	9S1H	41	16,7	16,1	I^b	0,70	141
9	0,8	1934	5S4H1O	81	24,0	30,1	I	0,65	207
10*	1,6	1966	6O2S2Ch+H	36	15,6	18,4	I	0,80	160
12	0,8	1934	6S2O2H	81	24,4	30,3	I	0,79	295
13*	1,6	1966	2O2S2Ch4H	46	16,2	20,1	I^a	0,80	160
15	0,8	1934	7S2O1H	81	24,3	30,6	I	0,76	295
16*	1,6	1967	3OS1Ch3H	46	16,8	16,5	I^a	0,80	170
21	0,8	1934	6S3H1O	81	24,7	30,8	I	0,63	235
22*	1,6	1967	2S1O1Ch6H	46	17,2	18,1	I^a	0,80	125

Note *: stands that were formed after the Kornakovskyi fellings

From Table 1.2 it can be seen that after the Kornakovskyi narrow fellings, stands with predominance of hornbeam or ash in their compositionwere formed. Thus, in locations 3, 6 and 22 the share of hornbeam in the stands made up 6-8 pcs, in locations 4, 7, 10, 13, 16 it was 1-4 pcs. In locations 4 and 7 ash stands were formed. The best level of regeneration of oak and formation of naturl stands was observed in location 10. A 36-year-old stand with a 6O2S2Ch+H composition was formed there. In location

13 and 16 the share of oak in the stands was 2-3 units.In other research areas, the oak regeneration was unsatisfactory. In composition of the stands, it accounted forno more than 10 % or was absent altogether. It should be noted that regeneration of oak yet took place in some years.In 1966 and 1967 it showed its best, what wasapparently connected with higher oak fruiting rates in previous years. On the felling areasof 1964 and 1965 the share of oak did not exceed 1-2 pcs. There was almost no oak in plantations that were formed after the 1968 felling [70].

Examination of the formed plantations indicates some suppression of oak by other species, what resulted in underdevelopment and oppression of its crowns. A significant number of oak trees of the 5th, 4th and 3rd Kraft classes were found. According to the foresters' assesment, these plantations almost every year show dead oak trees that are cut down during sanitary fellings.

Unsatisfactory regeneration of oak as a result of Kornakovskyi felling is also explained by its insignificant share in the composition of maternal and adjacent stands. Thus, in the stands adjoining to locations 2 and 5 oak was represented by single specimens, and in other stands (loc. 9, 12, 15, 21) its share was 1-2 pcs. Ash and hornbeam dominated in those stands, which mainly had formed their new generation in the researchareas of Kornakovskyi fellings.

By the time of the study, the age of the experimental stands was 36-46 years. They had different taxonomic indicators (see Table 1.2). Thus, the density of the experimental stands varied between 0.70-0.80, and the stock of the stem wood was 112-170 $m^3 \cdot ha^{-1}$. The largest stock was characteristic of the stands in locations 10, 13 and 16, where the share of oak was 2-6 pcs. Low stocks (112-114 $m^3 \cdot ha^{-1}$) of wood were inherentin ash-hornbeam stands in locations 3 and 6. The average height of stands varied between 14.2-17.2 m and diameter ranged from 12.6 to 20.1 cm.

In 1965, in quarter 59 in Ulashkiv Forestry a felling site for the uniform-gradual 3-step felling was allotted for a period of 20 years. The maternal 80-year-old stand had two storeys. The composition of the first storey was9O1H. The second storey was thin, represented by hornbeam, maple and linden. The average height of the first storey was 27.5 m, diameter – 37.0 cm, quality class – I^a, the type of the forest – fresh hornbeam grove. The stand of the 1st marketability class had seed origin with slight admixture (up to 10-15 %) of undergrowth specimens. Undergrowth was represented by biennial specimens of oak, which were unevenly distributed on the area. The undergrowth of hornbeam, linden, maple was very thin, uniformly spred over the area. Undergrowth consisted of dogwood, hazel and hawthorn. Itsamount was medium, distributed evenly over the area. The relief of the site was flat [70].

The site was divided into the following variants of the experiment (Fig. 1.2):

• three variants of gradual three-step felling and protective demarcation strips around them;

• control (solid felling);

• the area where no measures were held;

• protection strip between control and the area where no measures were taken.

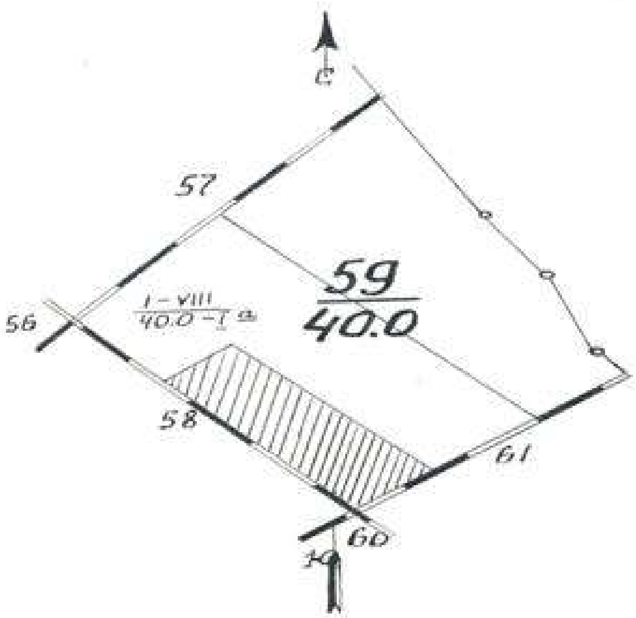


Fig. 1.2. Layout of the 3-step felling area (1965)

The first step of felling was performed in the fall of 1966. In addition, the following measures were taken at the site:

• in the spring of 1967, on the variant where acorns planting was planned, oak trees were grown according to the 5.0x0.5 m pattern;

• in the autumn of 1967, natural regeneration of oak was promoted by loosening the soil in 0.5 m wide strips every 5.0 m.

Thus, the area of gradual 3-step felling after the first cutting had the following variants of the experiment:

• section where 15 % of wood stock was felled without promoting natural regeneration;

• section where15 % of wood stock was felled with natural regeneration promotion by loosening the soil in strips;

• section where 15 % of wood stock was felled with the subsequent forest varieties creation;

• protection strips with 15 % of wood stock felling;

• felling of tree species of the second storey and undergrowth;

• protection zone;

• the area where no measures were held.

In 1966, on the permanent accounting areas, estimation of natural regeneration before felling was carried out on 3 variants of the experiment, on the variant with the removed second storey and undergrowth species, as well as on the area where no measures were taken. Re-accounting of natural regeneration (after felling) was carried out in the spring of 1967. The next two steps of gradual felling in this stand were not carried out. This was due to the lack of natural seed regeneration of oak and the death of its seedlings emerged after the first felling.

As of 1986, after the first felling, a single-storey 100-year-old oak stand of the Ia quality class with an average 50.1 cm diameter, 32.2 m height and 0.8-1.0 density had been formed. In 2006, a re-inspection of the areas where it was planned to conduct a 3-step gradual felling was carried out. In this year, the taxonomic characteristics of the stand in square 49 location 1 were as follows: composition – 10 O, age – 141 years, height – 31.5 m, diameter – 50.4 cm, density – 0.62, stock – 373 m^3/ha. Asit can be seen, the inventory indicators of this stand in 2006 remained at the level of 1986. This wasconditioned by the destructive processes associated with the death, fall and felling of the diseased trees [67].

Examination of this stand showed the complete absence of self-seeding, undergrowth and the second oak and other tree speciesstorey formation.

Conclusions. 1. Assessment of natural regeneration of the main forest-forming species of Podillia, common oak in particular, indicates its significant potential. The success of natural regeneration of the European oak depends on the fruiting availability, timely main use fellings, sufficient illuminatiom for self-seeding and low competition fromthe related species. Such conditions can be provided on the areas of solid fellings of oak stands in the seed year.

2. In order to ensure natural regeneration of oak forests in the region of research in 1965-1964 gradual 2- and 3-step fellings and fellings by the Kornakovskyi method were started.

3. The analysis of the conducted research and full-scale inspection of the experimental areas indicated the absence of positive results ofoak forests regenerationin conditions of gradual 2- and 3-step fellings. After such fellings, the young generation of oak stands was not formed. An undesirable change in species composition of woody plants (mainly hornbeam) took place in the 2-step felling area. The 3-step fellings were not completed, which led to the death of the undergrowth.

4. After fellings by the Kornakovskyi method, satisfactory results were obtained. The share of the European oak in the existing 40-year-old plantations made up 2-4 pcs. Oak trees were distributed unevenly in the area, and mostly in curtains. The largest share of oak was observed in the 1966-1967 felling areas (3-4 pcs) compared tothe 1965 and 1968 ones, where the share of oak did not exceed 1-2 pcs.

REFERENCES

1. Yisaschar-Mekuzas, Y., Jaffe, C. L., Pastor, J., Cardoso, L., & Baneth, G. (2013). Identification of Babesia species infecting dogs using reverse line blot hybridization for six canine piroplasms, and evaluation of co-infection by other vector-borne pathogens. Veterinary Parasitology, 191, 367-73. doi: 10.1016/j.vetpar.2012.09.002

2. Irwin, P. J. (2009). Canine babesiosis: From molecular taxonomy to control. Parasites & Vectors, 2(Suppl 1):S4.

3. Solano-Gallego, L., Sainz, Á., Roura, X., Estrada-Peña, A., Miró, G. (2016). A review of canine babesiosis: the European perspective. Parasites & Vectors, Jun 11;9(1), 336. doi: 10.1186/s13071-016-1596-0

4. Mokry, Yu.O., & Ksyonz, I.M. (2017). Epizootology monitoring of babezial invasion among dogs in Poltava. Scientific Messenger LNUVMBT named after S.Z. Gzhytskyj, 19(73), 149-153. (in Ukrainian). doi: 10.15421/nvlvet7331

5. Panti-May, J.A., & Rodriguez-Vivas, R.I. (2020). Canine babesiosis: A literature review of prevalence, distribution, and diagnosis in Latin America and the Caribbean. Veterinary Parasitology - Regional Studies and Reports, 21, 100417. doi: 10.1016/j.vprsr.2020.100417

6. Dantas-Torres, F., Alexandre, J., Miranda, D.E.d., et al. (2021). Molecular epidemiology and prevalence of babesial infections in dogs in two hyperendemic foci in Brazil. Parasitol Res. doi: 10.1007/s00436-021-07195-8

7. Lempereur, L., De Cat, A., Caron, Y., Madder, M., Claerebout, E., Saegerman, C. (2011). First molecular evidence of potentially zoonotic Babesia microti and Babesia sp. EU1 in Ixodes ricinus ticks in Belgium. Vector Borne and Zoonotic Diseases,11, 125-130.

8. Gryshchenko, V. A. (2020). Influence of phospholipid-containing additives on the functional condition of organs and systems of mice. Ukrainian Journal of Veterinary Sciences, 11(3), 14-23. doi: 10.31548/ujvs2020.03.002

9. Strobl, A., Kunzel, F., Tichy, A., & Leschnik, M. (2020). Complications and risk factors regarding the outcomes of canine babesiosis in Central Europe - A retrospective analysis of 240 cases. Acta Veterinaria Hungarica, 68(2):160-68. doi: 10.1556/004.2020.00031

10. Gryshchenko, V. (2015). The mitogen-stimulating effect of the milk phospholipids under in vitro experiments. Biological Resources and Nature Management, 7(1-2), 61-64.

11. Gryshchenko, V.A., & Bilokur, D.S. (2021). The general reaction of dogs in the acute stage babesian invasion. Ukrainian Journal of Ecology, 2021. – 11(5), 85-90. doi : 10.15421/2021_213

12. Serdyukov, Y. K., Lytvynenko, O. N., & Gryshchenko, V. A. (2008). Pathologo anatomical and histological changes are in liver of rats at a medicamentous hepatitis. Ukrainian Journal of Modern Toxicological Aspects, 2, 63–65. (in Ukrainian).

13. Defauw, P., Schoeman, J.P., & Smets, P. (2012) Assessment of renal dysfunction using urinary markers in canine babesiosis caused by Babesia rossi. Veterinary Parasitology, 190(3-4), 326-32. doi: 10.1016/j.vetpar.2012.07.023

14. Gryshchenko V. (2004). Intensity of lipids peroxidation and state of antioxidant protective system in calves, which have had dyspepsia. The Ukrainian Biochemical Journal. 76(5), 102-106.

15. Liebenberg, C., Goddard, A., & Wiinberg, B. (2013). Hemostatic abnormalities in uncomplicated babesiosis (Babesia rossi) in dogs. Journal of Veterinary Internal Medicine, 27(1), 150-56. doi: 10.1111/jvim.12016

16. Fraga, E., Barreiro, J.D., & Goicoa, A. (2011). Abdominal ultrasonographic findings in dogs naturally infected with babesiosis. Veterinary Radiology & Ultrasound, 52(3), 323-29. doi: 10.1111/j.1740-8261.2010.01775.x.

17. Gryshchenko, V.A. (2017). Biochemical properties of the plasma of rats with the experimentally induced hepatitis after oral administration of sodium diclofenac. Regulatory Mechanisms in Biosystems, 8(2), 191–196. (in Ukrainian). doi: 10.15421/021730

18. Conference on the Physics, Chemistry, and Biology of Water. Sofia, Bulgaria, October 26-29, 2017. [Electronic resource]. URL: http://www.waterconf.org/participants-materials/2017/ (date of access 27.02.2018).

19. Krasnobryzhev V.G., Kurik M.V. Properties of coherent water. Quantum Magic . 7 (2): 2161-2166, 2010.

20. Krasnobryzhev V. Global technological resource of macroscopic disloyalty. Coherent technology. Complementary coherent water. Monograph. - 2012 .-- 100 p. : www.ingimage.com

21. Surinov B.P., Khachumova K.G., Germanov E.P., Fedorenko A.A. Informational pharmacology is the reproduction of information copies of medicinal substances in aqueous media. Journal of Emerging Research Areas . 15-16 (5): 85-91, 2017.

22. Surinov B.P. Superweak radiation and modeling of the properties of biologically active substances. Overview. Radiation and risk . 27 (2): 28-36, 2018.

23. Khachumova K.G., Surinov B.P., Voeikov V.L., Germanov E.P., Fedorenko A.A. Technologies that challenge modern thinking: the transmission of drug properties through communication lines. JFNN . 2 (5): 108-117, 2014.

24. Etkin V.A. On the technology of creating and transferring "information copies" of medicinal products . Samizdat. 2015. [Electronic resource]. URL: http://samlib.ru/e/etkin_w/ otexnologiisozdaniyspektralnyxkopiy.shtml (date of treatment 12/25/2017).

25. Koltovoy N.A. Kirlian method. - Email resource: https://koltovoi.nethouse.ru

26. Krasnobryzhev V.G. Method and equipment for fuel modification. Sposób i urządzenie do modyfikacji paliwa / Polish patent for utility model No. 207357, filing date 5.09.2006, publ. 05.03.2007.

27. Pesotskaya L.A., Krasnobryzhev V.G., Mintser O.P., Glukhova N.V. Using the method of Kirlian photography for rapid assessment of the coherent properties of water. International Journal of Sustainable Development, 2: 21-29, 2021.

28. Pesotskaya L., Kovalchuk G., Glukhova N., Evdokimenko N. et al. Using the gas-discharge glow method to assess the health properties of water. International Journal of Sustainable Development. 2: 10-19, 2020.

29. Pesotskaya L.A., Mintser A.P., Glukhova N.V. Method for determining the degree of coherence of the state of water. Patent of Ukraine for invention No. 112809, filing date 2.03.15, publ. 10/25/16, Bul. No. 20.

30. Mintser O.P., Pesotskaya L.A., Gorovaya A.I., Glukhova N.V., Krachunov H., Evdokimenko N.M. Using Kirlian photography of water to assess its biological properties. International Journal of Sustainable Development. 2: 56-64, 2021.

31. Mikhailov V.A., Parkhomenko Yu.A. A device for energy-informational transfer of medicinal properties of drugs prepared according to the homeopathic principle. RF patent for utility model No. 4224 U1, filing date 04.22.96, publ. 06.16.97, Bul. No. 20.

32. Mintser O. P., Pisotska L. A., Glukhova N. V. Method of identifying information copies of a bioactive family. Patent of Ukraine for Korisna model No. 148443 application date 4.11.2020, publ. 08/11/2021 p. Bul. No. 32

33. Pisotska L.A., Lapitskiy V.M., Boatswain K.I., Gerashchenko S.V. Method of assessing the energy-informational mill for a single phase system and pristri for yogo health. Patent of Ukraine for Korisna model No. 22212 dated April 25, 2007

34. Pesotskaya L.A., Mintser O.P., Glukhova N.V. A device for registering an image of the Kirlian glow of biological objects. Patent of Ukraine for a useful model No. 100879 dated 08/10/2015 Byull. No. 15.

35. Kurik M.V., Pesotskaya L.A., Glukhova N.V., Evdokimenko N.M. Kirlinography of energy-informational interactions of water . Lithographer. Dnepropetrovsk, 2015 - 135 p.

36. https://www.syngenta.ua/korysna-agronomichna-informaciya/sonyashnyk/vysokooleyinovyy-sonyashnyk-novi-mozhlyvosti-dlya.

37. Vrbaski, Z. Oxidation stability of sunflower oil of altered sunflower after seed storage [Text] / Z. Vrbaski, M. Budincevic, J. Turkulov, D. Skoric, K. Vranac // Helia. – 1996. – No 24. – P. 73–78.

38. Dobarganes, M.C. Thermal stability and frying performance of genetically modified sunflower seed (Helianthus annuus L.) oils [Text] / M.C. Dobarganes, G. Marquez- Ruiz, M.C. PerezCamino // J. Agric.Food Chem. – 1993. – V. 41. – P. 678–681.

39. Glancey, J. L. Development of a high oleic soybean oil-based hydraulic fluid [Text] / J.L. Glancey, S. Knowlton, E.R. Benson // Feedstocks. – 1999. – V. 4, Iss. 2. – P. 1–2.

40. Fitch-Haumann, B. Modification of oil may be the key to sunflower‘s future [Text] / B. Fitch-Haumann // INFORM – Int. Newson Fats, Oiland Related Materials. – 1994. – V. 5. – P. 1198–1210.

41. Лебеденко Є. О. Створення вихідного матеріалу високо олеїнового соняшнику стійкого до дії гербіциду групи сульфонілсечовини / Селекція і насінництво. - 2016. - Випуск 109. - С 47-53.

42. Толмачев В.В. Новое направление развития культуры подсолнечника в Украине / В.В. Толмачев, Е.В. Медведева // Агроном. – 2010. – № 3. – С. 159–161.

43. https://www.agronom.com.ua/everest-ukrayinskoyi-selektsiyi/.

44. Войцеховська О.С. Стан і перспективи розвитку високоолеїнового соняшнику в Україні та в світі / О.С. Войцеховська, І.О. Войцеховський // Таврійський науковий вісник. – 2019. № 88. – С. 39 42.

45. https://www.syngenta.ua/news/sonyashnik/visokooleyinoviy-sonyashnik-trend-sezonu-2020

46. Кучерук З.І. Вивчення жирнокислотного складу олії високоолеїнового типуз насіння соняшнику та перспективи її використання у виробництві борошняних кондитерських виробів / З.І. Кучерук Н.В. Федак, А.М. Діхтярь, З.І. Носко, С.М. Тимчук // ХДУХТ. – Харків, 2010. – С. 117-122.

47. Очеретна А.В. Перспективи використання високо олеїнових сортів олії соняшника у продуктах функціональної дії для оздоровчого харчування / А.В. Очеретна, Н.Е. Фролова // Вчені записки ТНУ ім. В.І. Вернадського. Серія: технічні науки. – 2020. – Том 31 (70). – Ч. 2. – С. 129-135.

48. Султанович А.Ю. Высокоолеиновое подсолнечное масло – основа для фритюрных масел и жиров / А.Ю. Султанович, Т.А. Духу // Пищевая промышленность. – 2012. - № 3. – С. 22-24.

49. Seriburi, V., Akoh, C.C. Enzymatic interesterification of lard and high-oleic sunflower oil with Candida Antarctica lipase to produce plastic fats. J Amer Oil Chem Soc 75,1339–1345 (1998). https://doi.org/10.1007/s11746-998-0181-x.

50. Frankel, E.N., Huang, S.W. Improving the oxidative stability of polyunsaturated vegetable oils by blending with high-oleic sunflower oil. J Am Oil Chem Soc 71, 255–259 (1994). https://doi.org/10.1007/BF02638050.

51. Левицький А.П. Роль високоолеїнової соняшникової олії у вирішення проблеми жирового забезпечення сільськогосподарських тварин та птиці / А.П. Левицький, А.П. Лапінська, І.В. Ходаков, В.Д. Придорожко // Зернові продукти і комбікорми. – 2016. - Vol. 62. – С. 38-42.

52. Дьяков А.Б. Причины стабильности и вариации лузжистости семянок подсолнечника / А.Б. Дьяков // Доклады ВАСХНИЛ. – 1990. – № 8. – С. 12–15.

53. Жданов Л.А. Биология подсолнечника / Л.А. Жданов, Р.М. Барцинский, И.Ф. Ляшенко – Ростов: Ростовское областное книгоиздательство. 1950. – 270 с.

54. Козуб Н.М. Сучасний стан та перспективи виробництва насіння соняшнику / Н.М. Козуб // Таврійський науковий вісник. – 2006. – Вип. 47 – С. 223–226.

55. Кір'янчук В.Ф. Синтез і дослідження мономеру з високоолеїнової соняшникової олії та його полімеру / В.Ф. Кір'янчук, З.І. Демчук, Б.С. Домніч, А.М. Когут, О.Г. Будішевська, А.С. Воронов, С.А. Воронов // Питання хімії та хімічної технології. – 2020. - № 3. – С. 88-95.

56. Папченко В., Матвєєва Т. Дослідження умісту олеїнової кислоти олії високоолеїнового типу з насіння соняшнику // Multidisciplinary academic notes. Science research and practices. Proceedings of the XV International Scientific and Practical Conference. Madrid, Spain. 2022. Pp. 669-671. DOI:10.46299/ISG.2022.1.15

57. Kopii S. L. Osoblyvosti pryrodnoho vidtvorennia korinnykh derevostaniv u hrabovykh dibrovakh zakhidnoho rehionu Ukrainy [Features of natural regeneration of indigenous tree stands in hornbeam of the western region of Ukraine]: avtoref. dys. zdobuttia stupenia kand. s.-h. nauk: spets. 06.03.03 «Lisoznavstvo i lisivnytstvo». Lviv, 2010. 20 p.

58. Mazepa V. H., Krynytska O. H. Produktyvnist i stan vidtvorenykh pryrodnym nasinnym shliakhom derevostaniv u hrabovo-sosnovykh sudibrovakh Lvivskoho Roztochchia [Productivity and condition of reproduced by natural seed by tree stands in hornbeam pine forests of Lviv Roztochchya]. Nauk. visnyk NLTU Ukrainy. Lviv : RVV NLTU Ukrainy, 2012. Vyp. 22.9. P. 14-18.

59. Neiko I. S., Martseniuk O. P. Otsinka stanu lisovykh ekosystem u konteksti zbalansovanoho lisokorystuvannia ta zabezpechennia ekolohichnoi stabilnosti ahrolandshaftiv Ukrainy [Assessment of the condition of forest ecosystems in the context of balanced forest management and preservation of the stability of agrolandscapes of Ukraine]. Naukovyi visnyk: Zbirnyk naukovo-tekhnichnykh prats. Lviv : NLTU, 2008. Vyp. 18.10. P. 65-71.

60. Didenko M. M. Stan pryrodnoho ponovlennia duba zvychainoho pid nametom materynskykh derevostaniv [The state of the natural renewal of oak is under the parent tree]. Lisivnytstvo i ahrolisomelioratsiia. Kharkiv: UkrNDILHA, 2008. Vyp. 113. P. 186-190.

61. Vasylevskyi O.H., Pidpalyi I.F., Matusiak M.V., Samoilova N.O. (2015). Osoblyvosti formuvannia ta potentsial vykorystannia pryrodnoho ponovlennia duba zvychainoho v umovakh Podillia [The peculiarities of the formation and the potential of the use of natural oak conventional renewal in Podillya] / Visnyk Vinnytskoho NAU – Herald of Vinnytsia NAU. Vinnytsia: VNAU. № 7. P. 129-139. [in Ukrainian].

62. Vasylevskyi O.H., Yelisavenko Y.A., Neiko I.S., Monarkh V.V. (2017). Suchasnyi stan pryrodnykh dubovykh derevostaniv DP «Vinnytske LH» [The current state of the natural oak woodlands of the state enterprise «Vinnitsa forestry»] Visnyk Vinnytskoho NAU – Herald of Vinnytsia NAU. Vinnytsia: VNAU. №7 (Tom 1). P. 129-139. [in Ukrainian].

63. Vasylevskyi O.H., Neiko I.S., Yelisavenko Y.A., Matusiak M.V. (2018). Kharakterystyka struktury ta lisovidnovnykh protsesiv pryrodnykh dubovykh lisostaniv DP «Kryzhopilske LH» [Characteristic of the structure and forest-dependent processes of natural oak forests of SE «Kryzhopil forestry»] / Visnyk Vinnytskoho NAU – Herald of Vinnytsia NAU. – Vinnytsia, VNAU. (№ 10). – P. 19-29. [in Ukrainian].

64. Ploshchi probni lisovporiadni. Metod zakladannia [Square trial forest management. Method of laying]: SOU 02.02-37-476:2006. Chynnyi vid 2007-05-01]. (2006). K.: Minahropolityky Ukrainy – Ministry of Agrarian Policy of Ukraine. 32 p. (Standart orhanizatsii Ukrainy). [in Ukrainian].

65. Tkach V.P. (2009) Suchasnyi stan pryrodnykh lisostaniv duba zvychainoho Livoberezhnoho Lisostepu Ukrainy [The current state of the natural forests of the oak forest of the ordinary Left-Bank Forest-steppe of Ukraine]. Lisivnytstvo i ahrolisomelioratsiia – Arboriculture and agroforestry. Kharkiv: UkrNDILHA. Vyp. 116. P. 79-84. [in Ukrainian].

66. Tkach V.P., Vasylevskyi O.H., Samoilova N.O., Zlenko O.P. (2014). Doslidyty efektyvnist vykorystannia lisoroslynnoho potentsialu lisamy Ukrainy (rivnynna chastyna ta hirskyi Krym) i rozrobyty systemu zakhodiv shchodo pidvyshchennia yikh produktyvnosti ta formuvannia derevostaniv pryrodnoho pokhodzhennia: naukovyi zvit po temi № 2 [Investigate the effectiveness of the use of forest potential by forests of Ukraine (plain and mountainous Crimea) and develop a system of measures to increase their productivity and the formation of stands of natural origin: a scientific report on the topic № 2]. Vinnytsia: VLNDS. 26 p. [in Ukrainian].

67. Tkach V.P., Vasylevskyi O.H., Samoilova N.O., Zlenko O.P., Matusiak M.V. (2015). Doslidyty efektyvnist vykorystannia lisoroslynnoho potentsialu lisamy Ukrainy (rivnynna chastyna ta hirskyi Krym) i rozrobyty systemu zakhodiv shchodo pidvyshchennia yikh produktyvnosti ta formuvannia derevostaniv pryrodnoho pokhodzhennia: naukovyi zvit po temi № 1. [Investigate the effectiveness of the use of forest vegetation potential in the forests of Ukraine (plain and mountainous Crimea) and develop a system of measures to increase their productivity and the formation of stands of natural origin: a scientific report on the topic № 1.]. Vinnytsia: VLNDS. 53 p. [in Ukrainian].