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**NATURAL REGENERATION OF RAVINE-GULLY SYSTEMS AND  
FORMER ARABLE LANDS IN OVRUCH REGION**  
**ЕСТЕСТВЕННОЕ ВОЗОБНОВЛЕНИЕ НА ОБРАЖНО-БАЛОЧНИХ СИСТЕМАХ И  
ЗАЛЕЖАХ ОВРУЧЧИНЫ**

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**Abstract.** *The article evaluates the success of natural regeneration of European spruce on ravine-gully systems, Scots pine and other tree species on fallows.*

*It was found out that on the lands of the state forest fund of the State Enterprise «Ovruch Specialized Forestry» there is a rich natural renewal, which in the future will be able to replace the native stand. It is in good condition and will be able to perform its eco-approval functions under favorable circumstances. On the eroded lands of the state forest fund the main part is occupied by natural regeneration of European spruce in the amount of 3.4 to 15.0 thousand pieces per ha, which is sufficient for the reproduction of highly productive, biologically stable stands on these lands. Spruce regeneration is aged from 4 to 9 years and is characterized by the following biometric indicators: weighted average height – from 0.9 to 2.6 m, diameter – from 0.2 to 2.6 cm. An important indicator of the viability of natural regeneration of European spruce is its number, which ranges from trial areas from 2.1 to 8.5 thousand pieces per ha.*

*On the fallow lands of the agricultural firm «Polissya» in Ovruch district, the main share is occupied by the natural regeneration of Scots pine, in the amount of 0.7 to 2.1 thousand pieces per ha, which is not sufficient for the reproduction of native stands. According to biometric indicators that characterize the natural regeneration of Scots pine, hanging birch and gray alder 9–11 years of age are: height – from 4.0 to 4.6 m, diameter – from 9.0 to 9.9 cm. lands natural regeneration was insufficient. Unsatisfactory condition of natural regeneration on fallow lands has low quality and productivity, which is due to turfing, soil hardness, insufficient moisture (precipitation).*



**Key words:** natural regeneration, self-seeding, ravine-gully systems, fallows, success of natural regeneration, number of viable regeneration, native stand, European spruce, Scots pine.

**Introduction.** The transition of domestic forestry to the functioning of the principles of sustainable development leads to an increase in the volume of forest reproduction on the basis of their eco-adaptation reproduction, which provides maximum use in reforestation of natural regeneration of tree species. Since the restoration of Scots pine and European spruce is mainly the creation of forest crops in Ukraine, and recently more and more drying of forests of these tree species, natural regeneration will significantly save material costs for reforestation, ensure biodiversity and increase biological sustainability of plantations [5]. Also, afforestation of low-yielding lands compensates for the reduction of agricultural land by improving the ecological situation, increasing the productivity of adjacent lands, enriching biodiversity, restoring many species of fauna, and additional production of significant amounts of wood, especially when using these lands for forest plantations.

Ravine formation processes are typical for the territory of Ukraine, especially within the study region, where the relevant phenomena are dangerous and cause the destruction of large areas of fertile land [1, 7].

The composition of ravine-gully forest plantations includes: clogging, which are designed by drainage thalwegs of the bottom part of the hydrographic network; plantings on slopes, bottoms and cones of ravine removal; massive anti-erosion plantings on gully slopes, which have complex and varied conditions, which must be of complex structure with the mandatory presence of shrub species [3, 4, 5, 8].

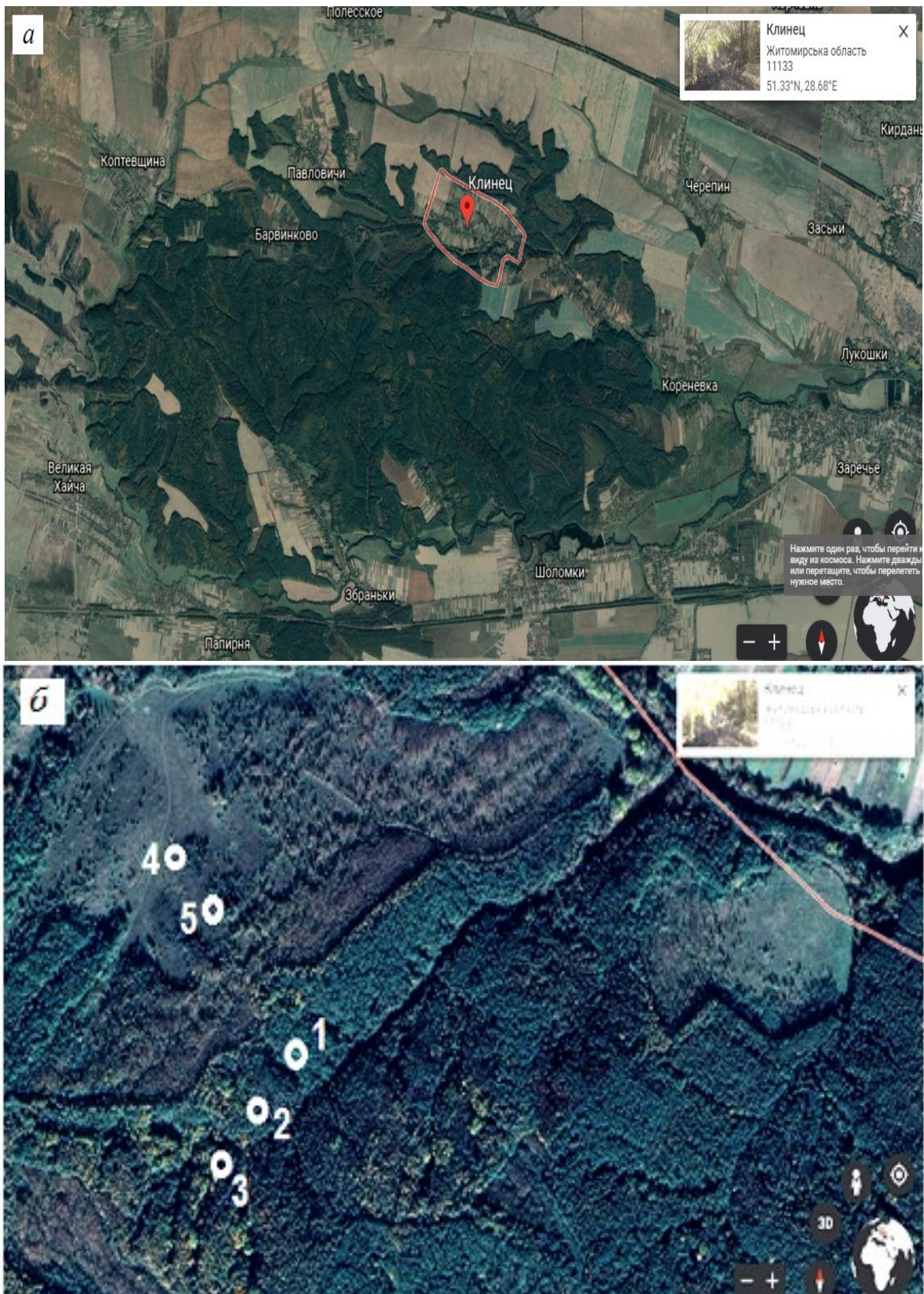
**The main text.** The purpose of the article was to assess the success of natural regeneration on ravine-gully systems and fallow lands in the Ovruch district of Zhytomyr region.

The object of the study was the natural regeneration of European spruce ravine-gully forest plantations of the state enterprise «Ovruch Specialized Forestry» and Scots pine and other species on the fallows of the agricultural company «Polissya» in Ovruch region.

To perform the planned tasks, square test plots measuring  $10 \times 10$  m ( $100 \text{ m}^2$ ) were laid in the village of Klynets, Ovruch district, Zhytomyr region, and 191 m above sea level.

In forestry, a special scale is used to assess the success of natural regeneration, which is given in the official «Instructions for the design, accounting and quality assessment of forest facilities» [1, 2]. The quality of seed and undergrowth is characterized by 4 quality classes. According to the method of P.M. Megalinsky [9] determined self-seeding by groups of heights and expressed them as a percentage. The condition of the specimens of natural regeneration was assessed on a scale of V.G. Nesterov [10] and «Instructions for the design, technical acceptance, accounting and quality assessment of forestry facilities» [1].

Before the start of field research, temporary test plots (TTP) were selected. They are located in the Koptivshchyna forestry of the State Enterprise «Ovruch Specialized Forestry» of the Zhytomyr Regional Department of Forestry and Hunting. A detailed description of the characteristics of natural regeneration was carried out at five TTP, and the locations of trial areas with GPRS coordinates are shown in Fig. 1.



**Fig. 1. Network of lying of trial plots and their location on the locality on Google map: General views of the territory of the state forest fund (a); test sites (b) Location of TTP-1 – Koptivshchyna Forestry SE «Ovruch Specialized Forestry» (block 54, unit 21, area 7.6 hectares). The composition of the mother stand on the TTP-1 – 5Ps5Bp, age – 45 years. Type of site – C<sub>2</sub>. Exposition of the slope is south-east, 3°. The characteristics of self-seeding are given in table. 1.**



**Table 1**

**European spruce self-seeding in the stands of Scots pine and birch hanging on ravine-gully systems**

No TPP	Aav., years	N, pieces	H, m	D, cm	Height groups, %			State, %			
					sm.	av.	height	vg.	g.	sf.	unsf.
1	2.7	9	–	–	88.9	11.1	–	–	11.1	33.3	55.6
	5.4	9	–	1.2	55.6	33.1	11.3	–	11.1	33.3	55.6
	7.9	5	2.5	2.0	–	60.0	40.0	20.0	20.0	20.0	40.0
	10.7	13	3.5	4.0	–	23.1	76.9	15.4	15.4	46.2	23.1
	13.5	7	3.5	3.5	–	42.9	57.1	28.6	28.6	28.6	14.3
	16.0	4	5.0	6.0	–	–	100.0	25.0	50.0	25.0	–
<b>Total</b>		<b>47</b>	–	–	–	–	–	–	–	–	–

**Note:** sm. – small; av. – average; height – high; vg. – very good; g. – good; sf. – satisfactory; unsf. – unsatisfactory. Ps – Scotch pine; Se – European spruce; Bp – hanging birch.

*Author's development*

Thus, the results of research show that the groups of heights at the age of 2.5–7.9 years are dominated by small and medium self-seeding, at the age of 10.6–16.0 years are dominated by medium and high, and instead of the state in at the age of 2.5–7.9 years the main share is occupied by an unsatisfactory state of natural regeneration, and at the age of 10.6–16.0 years the vast majority of spruce specimens have a very good and good condition. The number of natural regeneration trees that can replace the parent stand at the time of the study is 3643 pieces per ha, which is 77.5 %.

The composition of the mother stand of Scots pine and hanging birch is presented in Fig. 2.



**Fig. 2. Natural renewal of European spruce in the hanging birch stand (TTP-1)**



Temporary trial plot № 2 was laid in block 54, unit 25, which has an area of 7.6 hectares. Plantation composition is 7Ps3Se+Bp, age 70 years, Type of sites – C<sub>2</sub>. The characteristics of self-seeding are given in table 2.

**Table 2**

**European spruce self-seeding in stands of Scots pine and hanging birch on ravine-gullysystems**

No TPP	Aav., years	N, pieces	H, m	D, cm	Height groups, %			State, %			
					sm.	av.	height	vg.	g.	sf.	unsf.
2	2.5	56	0.5	–	64.3	25.7	–	8.9	8.9	35.7	46.5
	5.2	78	0.8	–	71.8	28.2	–	23.1	19.2	12.8	44.9
	7.9	6	1.3	–	16.7	33.3	50.0	16.7	16.7	33.3	33.3
	10.6	7	2.2	2.0	–	28.6	71.4	14.2	14.3	42.9	28.6
	13.3	1	4.5	5.0	–	–	100.0	100.0	–	–	–
	16.0	2	5.5	5.5	–	50.0	50.0	50.0	50.0	–	–
<b>Total</b>		<b>150</b>	–	–	–	–	–	–	–	–	–

*Author's development*

The largest part of the young generation of forests is accounted for by self-seeding of European spruce by altitude groups, mostly small and medium self-seeding up to 5 years old. Older trees of natural regeneration are dominated by tall specimens, and the condition is very good and kind, but unsatisfactory – absend. The number of naturally regenerating trees that can replace the parent stand at the time of the study is 8494 pieces per ha or 56.6 %. Natural renewal on ravine-gully systems in pine-spruce plantations is presented in Fig. 3.



**Fig. 3. Natural renewal of European spruce on ravine-gully systems in pine-birch plantations (TTP-2)**



The third trial plot was located in block 54, unit 18, with an area of 5.4 hectares. The composition of the plantation is – 6Ps4Se, age 70 years, type of sites – C<sub>2-3</sub>.

In this trial plot, the available self-seeding can fully ensure the restoration of indigenous stands of proper quality and productivity, which do not require costs and, most importantly, will be resistant to climate change and anthropogenic pressure. The characteristics of self-seeding are given in table 3.

**Table 3**

**Natural regeneration of spruce on the bottom and slopes of the ravine on eroded lands**

No TPP	Aav., years	N, pieces	H, m	D, cm	Height groups, %			State, %			
					sm.	av.	height	vg.	g.	sf.	unsf.
3	2.3	16	0.5	–	81.3	18.7	–	–	12.5	25.0	62.5
	5.0	9	1.2	–	44.4	44.4	11.2	11.1	33.3	22.2	33.3
	7.4	5	2.2	2.0	60.0	20.0	20.0	20.0	40.0	20.0	20.0
	10.3	2	2.7	2.8	–	50.0	50.0	–	50.0	50.0	–
	13.1	1	4.0	4.5	–	0	100.0	–	100.0	–	–
	16.0	1	5.5	6.0	–	0	100.0	–	100.0	–	–
<b>Total</b>		<b>34</b>	–	–	–	–	–	–	–	–	–

*Author's development*

Data of Table 3 show that the natural renewal along the bottom and slopes of the ravine on eroded lands by groups of heights up to 8 years of age is dominated by small and medium self-seeding and at an older age on the contrary – high. At the age of 10–16 years, natural regeneration has the best biometric indicators and is in good condition. The number of naturally regenerating trees that can replace the parent stand at the time of the study is 2100 pieces per ha or 61.8 %.

The location of the natural regeneration of European spruce on eroded lands is shown in Fig. 4.



**Fig. 4. Old curtain of European spruce with its natural renewal on eroded lands (TTP-3)**



The composition of the natural renewal on the trial plot of TTP-4 is 10Ps, age – 16 years, type of sites – C<sub>1-2</sub>. Exposition of the slope is northeast, 5°. Location – land of the agricultural company «Polissya». This area is laid on fallows (old arable lands) at a distance from the forest wall – 150 m. The characteristics of self-seeding on TTP № 4 are given in table 4.

Table 4

**Самосів природного поновлення сосни звичайної на перелогових землях**

No TPP	Aav., years	N, pieces	H, m	D, cm	Height groups, %			State, %			
					sm.	av.	height	vg.	g.	sf.	unsf.
4	7.9	3	2.8	6.0	–	33.3	66.7	–	–	40.0	60.0
	10.6	2	4.3	8.0	–	50.0	50.0	–	50.0	50.0	–
	13.3	2	4.9	11.5	–	–	100.0	–	–	100.0	–
	16.0	2	5.7	17.0	–	–	100.0	–	–	100.0	–
<b>Total</b>		<b>9</b>	–	–	–	–	–	–	–	–	–

*Author's development*

According to the obtained data, the natural regeneration of Scots pine on fallow lands is mainly represented by such groups of heights – average and high, small is absent. The condition of the tree is generally satisfactory and the best biometric indicators in terms of age and diameter. The number of natural regeneration trees that can replace the parent stand at the time of the study is 700 pieces per ha or 77.8 %. The natural regeneration of Scots pine on fallow lands is mostly satisfactory, due to the large turving of the soil and its hardness, low rainfall and light snowy winters.

Territorial location of natural regeneration of Scots pine on the fallow lands of the agricultural company «Polissya» is presented in Fig. 5.



**Fig. 5. Natural renewal of Scots pine on fallows (TTP-4)**



This plot is laid on fallows (old arable lands) at a distance from the forest wall – 230 m and is characterized by the data presented in table 5. The composition of the natural renewal on the trial plot TTP-5 – 2Ps3Bp5Alg, age – 13 years. Type of sites is C<sub>1-2</sub>. Exposition of the slope is northeast, 7°.

Table 5

**Natural renewal on old arable lands in the conditions of dry (fresh) oak site**

No TPP	Aav., years	N, pieces	H, m	D, cm	Height groups, %			State, %			
					sm.	av.	height	vg.	g.	sf.	unsf.
Self-seeding of pine											
5	5.2	1	4.2	8.3	–	100.0	–	–	–	–	100.0
	7.9	4	5.5	10.1	–	50.0	50.0	–	–	50.0	50.0
	10.6	1	6.5	12.0	–	–	100.0	–	–	–	100.0
	13.0	2	9.3	14.3	–	–	100.0	–	–	50.0	50.0
<b>Total</b>		<b>8</b>	–	–	–	–	–	–	–	–	–
Self-seeding of birch											
5	1.1	7	–	–	71.4	28.6	–	–	–	42.9	57.1
	5.5	3	4.5	8.3	33.3	33.4	33.3	–	–	66.7	33.3
	7.5	7	8.3	10.5	–	28.6	71.4	–	–	42.9	57.1
	9.2	3	13.5	12.3	–	33.3	66.7	–	–	33.3	66.7
	14.0	2	14.0	13.6	–	50.0	50.0	–	–	–	100.0
<b>Total</b>		<b>22</b>	–	–	–	–	–	–	–	–	–
Self-seeding of alder											
5	1.0	1	1.0	–	100.0	–	–	–	–	–	100.0
	3.7	4	4.5	8.1	25.5	25.5	50.0	–	–	50.0	50.0
<b>Total</b>		<b>5</b>	–	–	–	–	–	–	–	–	–
<b>Totally</b>		<b>35</b>	–	–	–	–	–	–	–	–	–

*Author's development*

Thus, the natural regeneration of pine, birch and alder on old arable lands in the conditions of dry (fresh) oak site is mainly represented by average and high specimens of pine, birch and alder, and the condition is dominated by satisfactory and unsatisfactory condition caused by suppression of some tree species by others, especially for light and nutrients. It is clear that the condition of such tree species on fallow lands is of low quality and productivity, because the soils are very poor, the growth and development of these species takes place on old arable lands or reserve lands.

Below is the territorial location of natural regeneration on old arable lands in the conditions of dry (fresh) oak site, which is presented in Fig. 6.

Territorial location of natural regeneration on old arable lands in conditions of dry (fresh) oak site is mainly represented by pioneer breeds, which have a satisfactory and unsatisfactory condition, which is caused mainly by low soil moisture and high turfing.





**Fig. 6. Natural regeneration on old arable lands in the conditions of dry (fresh) oak site**

**Conclusions.** Natural regeneration of European spruce on ravine-gully systems of SE «Ovruch Specialized Forestry» is in good condition, which is confirmed by viable trees that can replace the parent stand and make up from 56.6 to 77.5 % of the total number of specimens.

Provided that the natural regeneration of European spruce is preserved during forestry activities in the stands, it is advisable to use advanced methods and technologies of these cuttings. However, the generally known higher biological stability of natural forest cenosis and more effective performance of their protective functions, environmental friendliness of their formation, no doubt, compensate for the complications related to the provision in the formation of anti-erosion forest stands of natural origin.

In curtains where there is no self-seeding, it is necessary to mineralize the upper turf layer of soil in order to promote the emergence of natural regeneration. Due to the lack of proper forest vegetation conditions on the fallows, natural regeneration was determined to be insufficient for the formation of full-fledged forest stands.

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**Аннотація.** В статті проведена оцінка успішності естественного возобновлення ели европейской на овражно-балочных системах, сосны обыкновенной и других древесных видов на залежи.

Выяснено, что на землях гослесфонда ГП «Овручское специализированное лесное хозяйство» имеется богатое естественное возобновление, которое в будущем способно заменить коренной древесиной. Оно находится в хорошем состоянии и при благоприятных обстоятельствах сможет выполнять свои экоадаптационные функции. На эродированных землях гослесфонда основную часть занимает естественное возобновление ели европейской в количестве от 3,4 до 15,0 тыс. шт./га, что является достаточным для воспроизводства высокопродуктивных, биологически устойчивых древостоев на этих землях. Возобновление ели имеет возраст от 4 до 9 лет и характеризуется такими средневзвешенными

Биометрическими показателями: высота – от 0,9 до 2,6 м, диаметр – от 0,2 до 2,6 см. Важным показателем естественного возобновления ели европейской является его жизнеспособное количество колеблющееся в пределах от 2,1 до 8,5 тыс. шт./га. На залежных землях агрофирмы «Полесье» Овручского района основной удельный вес занимает естественное возобновление сосны обыкновенной, в количестве от 0,7 до 2,1 тыс. шт./га, что является не достаточным для воспроизведения коренных древостоев. По биометрическим показателям, характеризующие естественное возобновление сосны обыкновенной, березы повислой и ольхи серой 9–11-летнего возраста являются: высота – от 4,0 до 4,6 м, диаметр – от 9,0 до 9,9 см. Неудовлетворительное состояние естественного возобновления обусловлено, по нашему мнению, большим задернением и твердостью почв, конкуренции за питательные вещества и недостаточным количеством осадков.

**Ключевые слова:** естественное возобновление, самосев, овражно-балочные системы, залежи, успешность естественного возобновления, количество жизнеспособного обновления, коренной древесиной, ель европейская, сосна обыкновенная.

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