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ENSURING ENVIRONMENTAL SUSTAINABILITY OF FOREST ECOSYSTEMS ON DISTURBED LANDS WITH UNAUTHORIZED AMBER MINING

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Summary

Human activity is connected with the use of natural resources and conditions. The result of the intensive use of certain types of resources is the formation of disturbed and degraded lands, the change of natural landscapes. Negative changes in the natural state of land resources, the formation of degraded lands occur both as a result of economic activity and as a result of the action of natural factors.

A number of measures are used to restore unproductive, degraded, technologically polluted and disturbed lands. The complex of organizational, economic, technical and biological measures is determined by the factors that cause the occurrence of violations and the subsequent type of land use. Restoration and improvement of the land cover is carried out through its reclamation. This article describes and reveals the essence of the reclamation of produced peat deposits by its afforestation[1].

Reclamation of disturbed lands is a complex of organizational, technical and biotechnological measures aimed at restoring the soil cover, improving the condition and productivity of disturbed lands [2].

Land disturbance occurs during the development of mineral deposits, geological exploration, research, construction and other works, as well as due to the harmful effects of water. At the same time, the soil cover is disturbed or destroyed, the hydrological regime changes, man-made relief is formed, etc. As a result of land reclamation, agricultural and forest lands, reservoirs for various purposes, recreational areas, and areas for development are created on disturbed lands.

Introduction

Reclamation of disturbed lands, the land area of which in Ukraine, according to State Committee on Land Resources (SCLR), is more than 160 thousand hectares, restoration of their soil cover and return to the sphere of economic sectors, is one of the most important problems of nature management.

The goal of reclamation is not only the partial transformation of disturbed natural territorial complexes, but also the creation of more productive and rationally organized anthropogenic landscapes in their place. In connection with the increase in disturbed lands, reclamation has become an integral part of the protection and reproduction of land resources. Projects for reclamation of disturbed lands are developed on the basis of the task and design of technical conditions [2].

In the reclamation project, the technical and economic feasibility of reclamation is established, the type of further targeted use of the reclaimed land is substantiated, the scope of work of the technical and biological stages of reclamation is determined, and the most rational complexes of machines and equipment are selected.

Design organizations of the SCLR system, the Ministry of Agrarian Policy, the Ministry of Ecology and Natural Resources, and the Ministry of Education and Science of Ukraine are involved in the design of biological reclamation on contractual terms.

The development of individual sections of the project (extinguishing, development, lowering and reshaping of mine tericons followed by their landscaping) or landscaping projects without performing the work of the technical stage of reclamation is allowed to be carried out by divisions of production facilities with the involvement of specialized organizations on contractual terms or using the recommendations developed by them.

Materials of the technical project are transferred to the customer by the project organization (general designer) in four copies, and to the subcontracting project organization in five copies, except for objective estimates, the number of copies of which should be one more. In cases of execution of certain types of work by subcontracting organizations or land users, the project organization shall provide the customer with one additional copy of objective estimates for each subcontracting organization (land user). Working drawings are issued to the customer in four copies. The technical and working project is issued to the customer in the same number of copies as the working drawings.

Reclamation projects establish the economic efficiency of costs in the process of agricultural and fishery reclamation, which is determined by the time at which reclamation costs will pay off years

$$E_з = \frac{T \cdot B}{E_p} \qquad (1)$$

where *T* is the amount of costs for the technical stage of reclamation, UAH/ha;

B - the same for the biological stage, UAH/ha;

E_p - annual income from the sale of agricultural (fish) products from reclaimed (irrigated) area, UAH/ha.

The initial data for calculating the economic efficiency of reclamation is used from the following sources:

- costs for the technical and biological stages of reclamation - from the estimate to the project;

- a list of agricultural crops - from the structure of crop rotations in which the plot is expected to be used, or from the crop rotation, if they will be used outside the crop rotation; in the design of the reservoir, the species of fish that will be bred are established;

- costs for the production of a unit of production - from the materials of agricultural or fishing enterprises of the annual reports of farms located near mining enterprises;

- costs for processing and sales of products are estimated to be 7,2% of the total costs of products sold.

The comparative economic efficiency of biological reclamation can be calculated as at minimal costs

$$C_1+E_н K_p=\min \quad (2)$$

and for maximum profit

$$E_p-E_н K_p= \max \quad (3)$$

where C_1 - current costs for each option, UAH;

K_p - capital costs for reclamation1 ha of land, including production losses associated with land disturbance, UAH;

E_p - the total size of the average annual effect from reclamation1 ha lands, UAH;

$E_н$ - regulatory efficiency ratio of capital investments.

According to the State Forestry Agency of Ukraine, 3,5 thousand hectares of forest have already been damaged in the forests of the Rivne, Zhytomyr and Volyn regions due to unauthorized amber mining. This happens because illegal miners do not follow the mining technology, washing out the amber stone with motorized pumps, which leads to the destruction of underground water drainage channels. However, the reclamation of lands and forest plantations, which remain in a catastrophic state after the diggers, remains out of the attention of all participants in this industry [3].

Depending on the type of farming the reclaimed land will be used for (forestry or agriculture), the following types of work can be carried out. After the extraction of amber by hydraulic and mechanical methods, embankments and funnels are formed, first it is necessary to level the surface with the help of bulldozers and, if necessary, excavators. The next process of site reclamation consists in the fact that it is necessary to carry out the process of mixing milled peat with the surface layer. This operation can be performed with the help of tractors - tractors on a wheel drive with increased passability or on a crawler drive and cultivators or discs, which are used for disking land in agricultural works [3].

Reclamation of produced deposits and disturbed areas, as a result of unauthorized amber mining, through its afforestation is one of the world-recognized directions of their reclamation. The forestry direction of land reclamation is the creation of forest plantations of various types on disturbed lands. The requirements for land reclamation in the forestry direction should provide for the creation of plantations for operational purposes, and, if necessary, forests for protective, water-regulating, and recreational purposes.

To create conditions that prevent the development of erosive processes and the safe use of tillage, afforestation machines and plantation care machines, land surface planning works are carried out. They include works on the creation of forest plantations in unfavorable soil conditions that perform reclamation functions, selection of tree and shrub plants taking into account soil types, the nature of the hydrogeological regime and other environmental factors. The question of the organization of fire fighting measures must be considered.

When afforesting disturbed areas and produced deposits, it is advisable to follow the such recommendations [4].

- Because developed fields, after the extraction of minerals, are located on the lower parts of the terrain, their forestry use is possible only with high reliability of the drainage network.
- Forest growth conditions depend on the fertility and strength of the remaining layer of peat and the composition of the rocks of the mineral bed.
- Reclamation must be carried out in the first 2-3 years after the decommissioning of the areas, until the creation of a powerful grass cover and the natural restoration of the shrubbery (mainly verbolisis - thickets of willows). Overgrown areas require additional labor costs and funds for reclamation during their afforestation.
- Areas on which tree species have recovered well in the amount of at least 20,000 pieces/ha with their uniform located by area, are included in the forest fund without additional cultivation of crops.
- Natural regeneration of the forest.
- Soil preparation for afforestation depends on the category of the field according to the level of groundwater.

Natural regeneration of the forest on cultivated and disturbed agricultural and forest lands.

Natural regeneration of the forest depends mainly on the regime of groundwater, properties of peat, the presence of a source of insemination, etc. [5].

For the first 2-3 years, the developed areas are not overgrown with woody vegetation, only in some cases self-sowing willows and birches appear. Initially, they inhabit low-lying, waterlogged areas that are periodically flooded, and the slopes of the drainage network.

Then they spread throughout the massif. In areas that are flooded, self-sowing plants gradually differ in growth. Trees develop best on natural micro-elevations, low areas are overgrown with reeds, sedges, bulrushes, etc.

In the elevated areas, recovery is weaker due to the lack of moisture in the upper layers and the wind blowing the seeds to the lower areas. The species composition of self-regenerating crops is very limited: it is mainly downy birch, and aspen, pine, and spruce regenerate much worse. Aspen and spruce grow quite well in areas with groundwater level from - 0,2 to 0,6 m. Pine grows better in areas with a lower level of groundwater, that is, in elevated and medium areas [6].

A large number of self-sowing plants grow in areas with a deep layer of peat, because in the spring the peat swells up a lot, and with the onset of warm days it shrinks a lot.

In addition, areas with a significant layer of peat become overgrown with grass earlier and more intensively, which prevents the restoration of woody species. Therefore, produced deposits can self-restore, but the range of woody species will be quite limited, therefore, the main area of disturbed land should be subject to cultural afforestation.

Soil preparation

Processing soil has a decisive role in the productivity of forest plantations, as it determines the water-physical, air, agrochemical and microbiological properties of the soil. Types of processing include continuous processing (plowing), creation of micro-elevations and making furrows.

Continuous cultivation changes the layer in which the horizontal roots are located, which make up 90 % of the root system.

Creation of micro elevations in the form of shafts improves conditions on one part of the area due to deterioration (pits, furrows) on the other and enables crops to overcome the most unfavorable periods (flooding, waterlogging).

Conducting furrows worsens the agrochemical and water-physical properties in the areas and slightly improves them outside of them. It is used where the provision of moisture is crucial in the first years, as their bottom is moistened better than the slopes and ridges of the shafts.

The quality of any type of soil treatment depends on the type of treatment tool.

Soil processing in forestry production is carried out only when creating crops, then natural processes take place.

The choice of the method and terms of creation of cultures

The following ways of creating cultures are possible:

- the natural process of forest restoration as a result of self-sowing of seeds, but environmental conditions are not always favorable for the emergence of seedlings and their subsequent growth and development;
- sowing pine and spruce seeds 10-12 pcs. in the sowing place. The success rate of this method is low: 69-81% of the plants did not come off;
- the main method of reforestation is planting saplings. It is carried out manually or forestry machines. In low places where micro elevations are created, planting is carried out manually, since it is difficult to move equipment on the prepared soil and there is a high probability of significant damage to the shafts.

The success of forest crops strongly depends on the period of planting. Survival and preservation of plants planted in spring is much higher than in autumn.

The main reason for the loss of plants in low places is wetting and washing of plants (37-64%) and crushing (13-40%). Spruce is best stored here.

Autumn planting of medium and high fields is more successful, but also unsatisfactory in general. Pine seedlings are especially poorly preserved (41-75% loss).

Survival, conservation and success of cultivated tree species

The success of forest crops is evaluated by their survival after planting seedlings and by their growth rates. Their survival depends on the breed, the age of the planting material, the soil category, weather changes, susceptibility to the development of weeds, etc.

On medium and tall one-year-old pine saplings, this indicator varies from 87 to 100%, and decreases to 53-94% in two-year-olds. High survival rate (90-100%) of two- and three-year-old firs and 1-2-year-old birch, somewhat lower for aspen (48-79%).

On low fields survival of one-year seedlings pine trees is: on unprepared soil 89-95%, after plowing - 71-93%, on ridges of shafts 80-87%. Survival of two-year-olds does not exceed 37-86%. In spruce and birch, this indicator is much higher (97-100%), in black alder it decreases to 74-98%.

In all cases, survival on deep peat is significantly lower than on a mixture of peat and sand.

On areas prone to intensive overgrowth with weeds, use large saplings up to 0,4-0,6 m, which allows you to get rid of time-consuming and costly expenses.

In terms of growth indicators, warty and downy birches are the best in low fields.

Pine accelerates growth in height only from the second year, spruce from 4-5, and birch and alder, under favorable conditions, already from the year of planting.

Large pine and spruce saplings tend to get sick after 2-3 years and only then develop normally. Alder, spruce, aspen, poplar, oak suffer from freezing in depressions of middle fields.

Successful development of breeds that grow quickly and build up a significant mass of roots, which fasten the peat soil before the beginning of the autumn-winter season. These species include poplar or energy willow (Fig. 1).

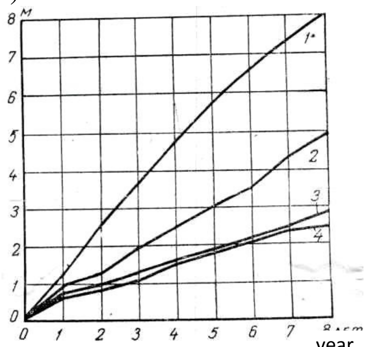

Fig. 1. Growth of crops on various produced peat deposits: *1* - cultured peat; *2* - produced edge; *3* - deeply peated areas, low fields; *4* - shallow bottom deposit

Having analyzed fig. 1. it can be concluded that only on cultivated (processed and fertilized) uncultivated outskirts, shallow areas with favorable aeration, these cultures form highly productive plantations.

Care of forest crops

The preservation and growth of crops strongly depends on the development of weeds and the application of mineral fertilizers.

Weeds and their growth dynamics differ significantly in different cultivated fields. The most intensive development of weeds onfertile deposits of low fields. These are hypericum, cypress, thistle, quinoa, common wormwood, etc., which reach a height of 60-80 cm, the degree of coverage is 70-100% and at the same time it is increasing 8-18t/ha of green mass, then grasses take root, which after 4-5 years form a solid sod.

Medium- and poorly decomposed peat is covered with mother-and-stepmother, marsh horsetail, occasionally reed. They develop weakly, so they are not a threat to the development of cultures.

There are mechanical and chemical methods of weed destruction. Among the first, loosening of the inter-rows with cultivators, weeding with hoes, mowing of weeds and their trampling by various means are used. The efficiency of the mechanical method is low.

The best results are observed with the use of chemical agents, among them triazine herbicides such as radocor, simazine and atrazine. When entering 20 kg of the active substance per hectare of soil, they thin out the grass by 80%. Their effectiveness depends on the terms of introduction. The most effective application is before the emergence of weeds.

Application of mineral fertilizers

Application of mineral fertilizers to accelerate forest growth is necessary due to the poverty of the substrate for phosphorus and potassium.

Application of only nitrogen, potassium and copper-containing fertilizers ($N_{60}Cu_{12}$ and $N_{60}K_{120}$) does not cause noticeable growth of weeds. Superphosphate ($N_{60}P_{90}$ and $P_{90}Cu_{12}$) and especially phosphorus-potassium fertilizers intensively provoke the growth of weeds, which reduces the squeezing of seedlings, protects them from frost and burns, that is, contributes to their preservation.

A significant acceleration of the growth of forest crops is observed with the introduction of phosphorus-potassium mixtures and various combinations of complete fertilizers, in which the potassium content exceeds the phosphorus content. Already in the first year, growth in height increases by 2-7 times. The best mixture is phosphorus-potassium fertilizers in the ratio $P_{90}K_{120}$ of the active substance. Fertilizers must be applied to pine and spruce crops that are no older than 5 years and birch trees that are 2-3 years old.

There are various methods of introduction. It is most rational to spread over the surface of the soil in the spring, before it thaws, since during this period the use of wheels is possible them tractors. Agricultural spreaders are used (СТН-2,8; РТТ-4,2; РУМ-2; 1-РМГ-4, etc.).

Economic efficiency of afforestation of disturbed and produced forest areas due to mining

The main method of developing low fields for afforestation is manual planting of forest crops in ridges and dumps.

Of the methods of care, chemical weeding showed the best results, but even one-time treatment increases the cost of growing crops by 30%. The involvement of areas covered with shrubs doubles the cost of afforestation. The produced areas must be rehabilitated in the first two years after the end of mining, before the development of a powerful grass cover and before the start of the natural recovery of the willow trees.

Labor and money costs can be reduced by combining soil preparation with planting seedlings into one operation. Cultivation of low-lying fields for sown grasses (that is, for agriculture), even with the introduction of significant doses of mineral fertilizers, is relatively inexpensive for farms. And already in the first year, you can get 2-3 tons of hay per hectare, and the labor costs are 14 times lower than during afforestation.

In the conditions of medium fields, mechanization of all crop growing processes is possible. Mechanized planting without soil preparation is the most economical. Application of mineral fertilizers in medium doses ($P_{90}K_{120}$) increases costs by 35%.

The cost of developing these fields under agriculture is approximately the same. But the payback of different methods of afforestation and agricultural use differs significantly: - when growing pine, silvicultural measures are paid for in 8-21 years, spruce in low fields and in fertile areas of the middle strip - in 10-12 years, alder in flowing deposits in 11-18 years, birches in medium and high fields for 17-20 years.

Growing natural birch plantations, which are often formed in low fields, do not require any costs, but their value is always lower than timely planted pine and spruce crops with a payback period of no more than 10 years.

Cultivation of sown grasses in low fields with fertile peat pays for itself within the first year, and with a rotation of crops (3 years) can bring a significant profit. It is even more profitable to grow cereals, even such a low-yield crop as oats.

Conclusions

Therefore, deposits produced during unauthorized extraction of amber and minerals are more profitable to use in agricultural production. It is most appropriate to grow pine on fields unsuitable for meadow and field use, prepared for mineral soil and with little decomposed peat.

In areas prone to dense population of birch and willow trees, it is economically expedient to focus on the production of spruce, the costs of labor and funds for its cultivation are always lower than for the formation of pine plantations, since silvicultural care and unprofitable lighting are reduced. For growing poplar, it is better to use shallow areas of middle fields, where grain and row crops give a low yield.

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