

## ECOLOGICAL RECONSTRUCTION OF TREES - A CASE STUDY FROM SINGEREI FOREST DISTRICT

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### Abstract

*The forest ecosystems of the Republic of Moldova constitute a strategic natural biotic potential, which through their structural and functional diversity include the most valuable associations of natural vegetation. Degradation of forest resources influences the state of other natural resources and can be a limiting factor in the development of the local and national economy as a whole. Thus, there is a need to carry out a detailed analysis of the dynamics of forest landscapes using modern research methods and means, in order to develop possible measures for their ecological reconstruction, which, along with other activities, would ensure the sustainable development of society. In this context, for the installation of a forest crop it is very important to use high quality reproductive forest material that is compatible with the planting area. A current example of the research presented evokes the purpose of this paper. The objective of this study was to organize the ecological reconstruction of the stands in the Singerei Forest District. The monitoring of the afforested lands by natural or artificial way in the respective area, was carried out practically from the period 2018-2021 for: a) meadows or gaps destined for afforestation - 185.97 ha, of which only 92.97 ha have been afforested so far; b) degraded lands destined for afforestation - 96.81 ha, of which only 50.88 ha have been afforested so far. Overall, the main species is the White Acacia (*Robinia pseudoacacia* L.) then the Pedunculate Oak (*Quercus pedunculata*) and the Red Oak (*Quercus rubra*). As a methodology for the collection and processing of primary materials, the method applied to eco-logical landscaping and reconstruction works was used according to the technical norms in force. The scientific study carried out in spring and autumn, regarding the ecological reconstruction in the Singerei Forest District has its investigation from 2018-2021. The competitiveness of these totally derived works during the last years, has obtained forest crops with a very good success of the main species, being thus, possible to obtain new stands and at the same time, defending understood and unregenerate gaps.*

**Key words:** ecological reconstruction, Northern Republic of Moldova, Singerei Forest District

### INTRODUCTION

In the conditions of the Republic of Moldova, with limited forest resources and a continuous pressure on forest ecosystems and their biodiversity, the integrity and security of forests becomes an imperative for the whole society (Galupa and Talmaci, 2011). The composition of Moldova's forests is dominated by deciduous species (97.8 percent), including quercinea - 39.6 %, ash trees - 4.6 %, hornbeam - 2.6 %, acacia - 36.1 %, poplar - 1.6 % etc., the conifers being presented only in proportion of 2.2 % (IPM, 2020).

According to the Land Cadastre from 01.01.2021, the total land area on the Republic of Moldova is 3384.7 thousand ha, the forest fund - 448.2 thousand ha, agricultural land - 2091.88 thousand ha. Thus, the degree of

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afforestation on the territory of the Republic of Moldova is 13.2 % (GD, 2021).

Analysing the literature, it was found that, in the years 1860-1861, following the first forest management, the area of the forest fund on the territory of Bessarabia was determined, comprising 288 091 dozen, which represents approximately 11 % of the total territory (Cuza, Boaghie, 2001).

Until the development of 1860-1861, which laid the foundations for the sustainable management of the forest fund, forests were cleared with selective felling in order to mark and extract from the tree well-formed trees, phenotypically superior in terms of productivity and quality wood, being left in the stands those of low economic interest and phenotypically inferior.

During this period, through cuts of all kinds, the area covered with forests decreased considerably. Irrational management of forestry, overexploitation of forests, illegal logging, grazing has contributed to reducing forested areas but also to reducing quality by changing the builders of forest communities with less valuable species with the prevalence of groves regime (Gheideman, 1969).

The notion of ecological reconstruction of forests is relatively new. The concept of ecological reconstruction of forests was first formulated in the forestry literature by academician V. Giurgiu (Giurgiu, 1981; Giurgiu, 1995). The fundamental objective of ecological reconstruction is to restore, as far as possible, the structure of trees damaged by anthropogenic or natural factors to the existing structural states before its impact on close states of these (Giurgiu, 1978).

According to Chiriță, 1986, ecological reconstruction in the strict sense must be understood as an action of renewal, of total restoration of the natural vegetation, which exists on a certain territory and which has disappeared or is variously degraded and therefore unjustified to be maintained further from economically, as well as the exercise of certain functions.

In the former USSR, the issue of ecological reconstruction of underproductive forests was first addressed in 1954 in St. Petersburg at a meeting of foresters in some neighboring regions. Thus, during this meeting, Tiulpanov proposes the installation of forest crops by direct sowing or planting on the entire surface in stands with a consistency below 0.5 and their creation in strips or corridors in stands with a consistency above 0.5 (Boaghie, 2004).

At the same meeting, it proposes to carry out ecological reconstruction works of juvenile by productive trees (age class I-II) in Ukraine by introducing the main species in corridors in trees with a consistency of more than 0.5 and in strips in trees with a consistency below 0.5 (Boaghie, 2004).

An overall analysis of the forest landscapes in the Republic of Moldova reveals that the most profound changes took place in the nineteenth century,

when there is an expansion of agricultural land, a phenomenon that continues in the twentieth century. Thus, the forest area decreases from 547 thousand ha in 1812, to 261 thousand ha, in 1901. In the last 60 years the forest area has expanded, registering on 01.01.2011 of 446.7 thousand ha, but their ecological balance, through excessive parcelling and the introduction of invasive species (in most cases acacia) remains unstable (Boboc, 2014).

Within the forestry researches in the Republic of Moldova, two research directions can be distinguished, namely (IPM Yearbook, 2020): geobotanical research on forest formations and forestry research itself, a direction developed especially by scientific collaborators. Lands subject to ecological reconstruction works are classified into 5 categories: poorly productive stands; derived trees; degraded stands (with a consistency below 0.3); braced stands (with a consistency of 0.4-0.6) and unsuitable stationary artificial stands. The most valuable stands of the forest fund are the oak trees (Technical norms, 2012).

According to reports in the field, of their total area – 27 % come from seed and 73 % from shoots, which also influences their productivity, thus, 43 % being of higher productivity and 57 % of lower productivity (Statistical Yearbook of the Republic of Moldova, 2021). During the twentieth century the forest areas of the Republic of Moldova had increasing tendencies by about 30 thousand ha annually. However, at the beginning of the 21<sup>st</sup> century, there is a tendency to reduce forest areas, so in these conditions it is necessary to remodel the forest management in order to maintain the forest fund and its efficient use (Moldsilva Agency, 2021).

A rather significant contribution that we want to note in this article, is the fact that in the Forest District of Singerei works as forester Mr. Jurjiu Vasile - born on 22.04.1958, with studies in the field of forestry and was employed since 1981. In the year 2021 celebrated 40 years of activity in this field being awarded the badge of merit for the work submitted in recent years by the management of the Agency Moldsilva - administrative authority under the central environmental body of public administration of the Republic of Moldova.

## **MATERIAL AND METHOD**

As an object of study in research are the stands for ecological reconstruction within the Singerei Forest District in the North of the Republic of Moldova. To achieve the objectives, the research used various methods for collecting data and obtaining results, namely: bibliographic documentation, observation, experiment, processing of primary data and analysis of results. In addition to the works and specialized materials, documents from the archive of the researched object were consulted.

The evaluation and highlighting of the trees of the resort and the study of the history of the works carried out during the years 2018 - 2021 were carried out by consulting the materials from the Forest Arrangements of the Singerei Forest District and in parallel with their field study.

A database has been prepared for 2021 on: area, plots in the forest canton, field works on forest management, type of soil, mobilization plan for planting forest crops of ecological reconstruction, ecological reconstruction and strengthening of forest sectors.

As a research method, the observation was the basis of the general analysis of the studied territory and the selection of stands, as well as landscaping units, where test surfaces were placed in order to investigate the particularities of ecological reconstruction works.

The research was carried out within the forestry entities subordinated to the „Moldsilva” Agency, namely, the Singerei Forest District from Singerei district (Fig. 1).

Before planting, the Singerei Forest District draws up the forest crops project. In the second stage, the soil preparation is done manually or mechanized. Manual soil preparation - called the hearth method - is done on lands degraded by the erosion process: steep ravines and slopes. The preparation of the mechanized soil - by the method in strips and integral - is done in glades and hollows.

The strips are prepared at a distance between rows of 3 m and between seedlings of 0.7 m. However, the soil preparation scheme is 3 x 0.7. The method of afforestation in the researched area is carried out by seedlings, seeds (especially oak), in nests and in envelopes.

For example, in the crop project the field works indicate the afforestation formula: - Oak-Oak-Oak; Paltin-Shrubs-Paltin, so it will be: oak – 70 %, paltin – 15 % and shrubs – 15 %. It is known that the required planting material per 1 ha is 4700 seedlings. The composition of the forest is: 7 Oak 2 Paltin 1 Shrubs. Then we get: 1)  $4700 \times 7 = 3290$  oak seedlings, 2)  $4700 - 3290 = 1410$  total paltin and shrubs, of which 3)  $1410 : 3 = 470$  seedlings and according to the scheme of forest composition (if we have 2 paltin) there will be 940 paltin seedlings and 470 shrub seedlings.

After planting, we move on to the next stage, namely, the care of forest crops. Methods and procedures of care, their periodicity varies depending on the trees. If we have oak: year I - IV quarter of care; year II - third trimester of care; year III - second trimester of care; year IV - first trimester of care. If we have acacia, the care is carried out for 3 years: the first year - the third trimester of care; year II - second trimester of care; year III - first trimester of care.

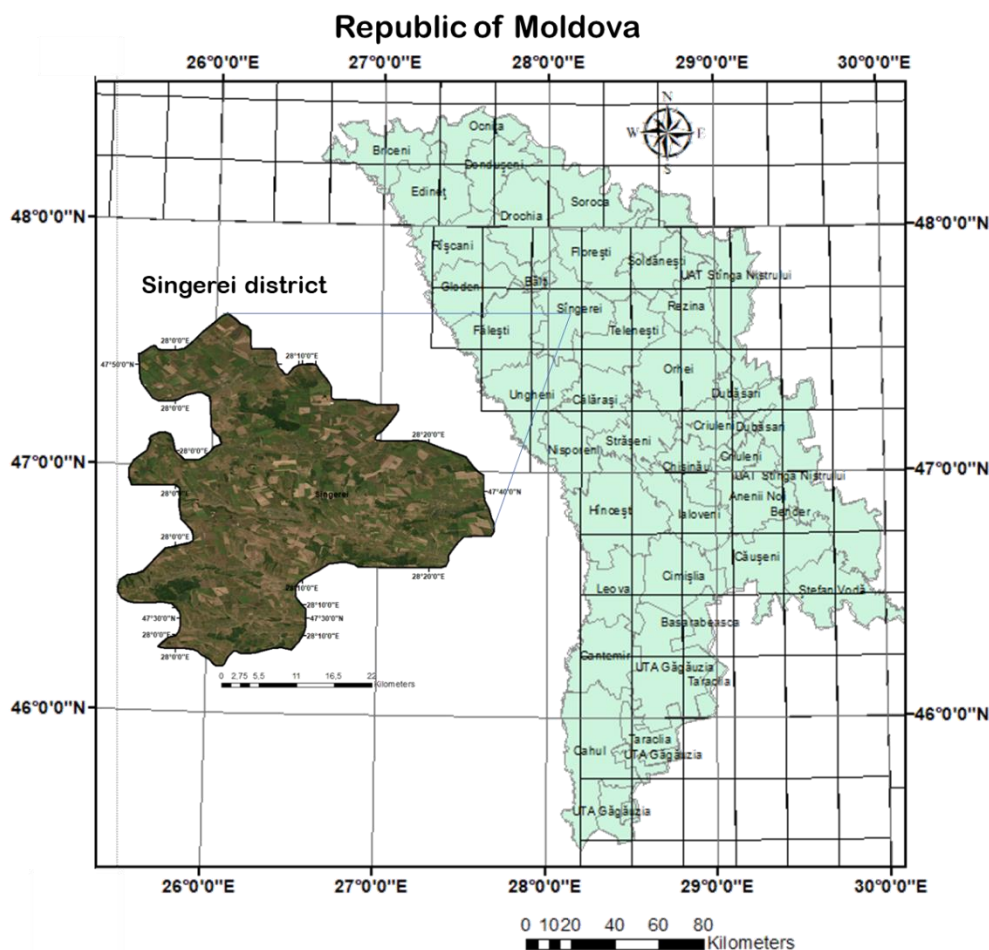


Fig. 1. Map of the location of Singerei district on the territory of the Republic of Moldova, created by the authors using ArcGIS software

When the forest crops already crowned between the rows and on this row with a percent of less than 78 % - they go into a state of massif, and in the final stage, forest crops are preparing for felling.

As a result of the investigation of the history of the works carried out according to the Singerei Forest District plan regarding the plantation inventories, it was found that ecological reconstruction works were carried out: in the spring of 2018.

The trees scheme was used of acacia - 3.0 ha, gledice (*Gleditsia Triacanthos*) - 4.1 ha, ash (*Fraxinus excelsior L.*) - 1.6 ha, oak - 0.4 ha and autumn on an area of 6 ha totally with acacia trees; in the spring of 2019 the scheme of acacia trees was used - 29.4 ha, ash - 4.4 ha, gledice - 3.9 ha, paltin (*Acer pseudoplatanus*) - 1, 4 ha, poplar (*Populus L.*) - 0.6 ha, oak - 2.0 ha, and in autumn on an area of 14 ha totally with acacia trees; in 2020 in spring

using the scheme of acacia trees - 33.3 ha, oak - 1.0 ha, ash - 2.0 ha, and in autumn the scheme was used of acacia trees - 31.5 ha, oak - 2.0 ha, ash - 4.5 ha.

According to the geomorphological reasoning of the Republic of Moldova after Boboc and Levadniuc, 1979, Singerei Forest District it is located in the Ciuluc - Soloneț plateau in the northern part of the Singerei district at altitudes of 250 - 325 m, on a typical chernozem, and gray soils appear downstream (Ursu, 2006).

## RESULTS AND DISCUSSION

In the post-war period, the forest district of Singerei underwent essential changes. Currently, the structure of the forest district is dominated by diverse trees, registering an increase of areas occupied by shrubs, forest protection curtains, formations that also contribute to increasing the productivity of agricultural land by about 8 % (IPM Yearbook, 2020).

The current arboretum in the Singerei Forest District, for the most part, is represented by secondary forests. Their composition is dominated by deciduous species, which include acacia, oak, hornbeam, beech, ash, linden, maple (Statistical Yearbook of the Republic of Moldova, 2021).

Currently, the total land area in Singerei district is 102660 ha, of which agricultural land is 56398 ha, and the forest fund is - 11546 ha. Thus, the degree of afforestation constituting 11.2 % (IPM Yearbook, 2020, 2021).

In order to conserve and protect the vegetation of the reserve and especially the endangered species, it is necessary to restore and/or restore the fundamental stands. These measures applied in the Singerei Forest District have a great role in protecting and conserving biodiversity (Technical norms, 2012).

From a geological point of view until the middle of the Pliocene, the area of the Singerei Forest District was a high plateau from where erosion bit almost the entire initial surface of the late Miocene. In the middle of the Pliocene, while the surrounding territories rise, the researched territory framed in the Bălți plain descends.

The geological profile is represented by Neogene sediments, the Sarmatian floor, with layers of sand, clay, limestone and marl. The Răuțel River cut its riverbed along the Răuțel fault, which is further downstream the Răut riverbed (Ursu, 2006).

In order to successfully implement the methods of ecological reconstruction of the stands, regarding the restoration and replacement of the given area, it is necessary to highlight that planting works were carried out in 2021 of the assortments of resistant trees and shrubs by the workers of the Singerei Forest District, and on the lands affected by the erosion process (Fig. 2).



Fig. 2. Field works on forest management and ecological reconstruction in the Singerei Forest District

According to the ecological reconstruction plan for 2021 in the Singerei Forest District, the monitoring of the care works of the affected areas and the ecological re-construction were carried out with the strengthening of the state forestry sectors (Tables 1-2). In Table 3 are presented the surfaces of the ecological reconstruction works carried out so far on the forest canton.

Most of the trees in OS Singerei are acacia, with an advanced degree of drying, they have different ages, they are pure, rarely scattered specimens of *Acer platanoides*, *Frax-inus excelsior L.*; in the coppice - *Acer tataricum*,

*Cornus sanguinea*, Mahaleb cherry, *Ligustrum vulgare*. Edge is composed of: *Prunus spinosa*, *Elaeagnus angustifolia* L., *Rosa canina*.

Table 1

Planning of field works regarding forest management					
The name of the indices	Total annual area, ha	Including quarterly, ha			
		I	II	III	IV
Planting forest crops	37.6	-	24.0	-	13.6
Helping natural regeneration	51.1	-	51.5	-	-
Forest crop care	368.1	-	158.1		-
Completion of forest crops	20.0	-	5.0	210.0	15.0
Soil preparation	44.9	-	21.3	-	10.0
Transmission of forest crops in a massive state	15.0	-	-	13.6	15.0

The drying process starts at the age of a few years (3-4), and in the roasting phase begins the mass drying. The age when the mass drying is totally depends on the properties of the soil, the abundance of precipitation and last but not least the weeding.

The soil cover was first researched in the field (on 14.06.2021 due to the COVID-19 pandemic restrictions in our country), where the pedogenetic profiles were excavated and analyzed. The pedological profile investigated on plot 83C2 was located in the middle part of the south-western slope, which has an inclination of 6 - 8°. According to the traditional geopedological methodology, the morphology of the genetic horizons was highlighted and characterized.

As a result of the examination of the pedological profile, we state that the soil cover is homogeneous, and the litter is made up of organic residues at different stages of decomposition, gray-brown. Thus, the morphological description of the typical chernozem profile moderately eroded, moderately humiferous, clay-loamy (plot 83C2):

*Ah0Ah1* (0 - 14 cm) - dark gray, moist, slightly compacted, dry color is light gray, medium nuciform and glomerular structure, stable, small and many pores, the presence of roots, clay-loamy.

*Ah1Bh* (14 - 24 cm) - light gray, weakly pronounced structure, nuciform, clay-loamy.

*Bh* (24 - 44 cm) - gray, poorly pronounced polyhedral structure, illuvial, compacted, clay-loamy.

*Bck* (44 - 64 cm) - yellowish gray, uneven, unpronounced structure, compacted, carbonates present, clay-loamy.

*Ck* (64-150 cm) - yellowish, inhomogeneous, pronounced presence of carbonates, clay-loamy.



The profile of the researched soil is differentiated Ah1Bh - eluvial, with the gradual transition to Bh - illuvial. The structure is poorly pronounced, not very stable.

Table 2

Planning of field works regarding forest management

Plot, subplot	Surface, ha	Species	Soil preparation method	Location scheme	The number of planting material used for the forest composition scheme
2F1	1.0	Acacia	mechanical	3.0 x 0.7	3
2F2	1.0	Acacia	mechanical	3.0 x 0.7	3
30J	0.6	Oak	mechanical	3.0 x 0.7	2
27F	0.9	Acacia	mechanical	3.0 x 0.7	3
4D	1.0	Acacia	mechanical	3.0 x 0.7	3
6T	1.0	Acacia	mechanical	3.0 x 0.7	3
19A1	0.6	Acacia	mechanical	3.0 x 0.7	2
19A2	0.5	Acacia	mechanical	3.0 x 0.7	2
19N	1.0	Oak	mechanical	3.0 x 0.7	3
19N1	1.0	Oak	mechanical	3.0 x 0.7	3
39H2	1.1	Oak	mechanical	3.0 x 0.7	3
39H2	1.1	Oak	mechanical	3.0 x 0.7	3
39H1	1.0	Oak	mechanical	3.0 x 0.7	3
36L	1.0	Acacia	mechanical	3.0 x 0.7	3
25P	0.5	Oak	mechanical	3.0 x 0.7	2
60L1	1.0	Ash	mechanical	3.0 x 0.7	3
Total	14.3 ha				
95H	1.0	Acacia	mechanical	3.0 x 0.7	3
83N2	0.9	Acacia	mechanical	3.0 x 0.7	3
83N1	1.0	Acacia	mechanical	3.0 x 0.7	3
83C2	1.0	Acacia	mechanical	3.0 x 0.7	3
61Q2	1.0	Oak	mechanical	3.0 x 0.7	3
50G	1.1	Oak	mechanical	3.0 x 0.7	3
Total	6.0 ha				
256M	0.4	Oak	mechanical	3.0 x 0.7	2
274N	1.0	Ash	mechanical	3.0 x 0.7	3
208E	1.0	Ash	mechanical	3.0 x 0.7	5
208A	1.7	Ash	mechanical	3.0 x 0.7	8
Total	4.1 ha				
<b>TOTAL</b>	<b>24.4 ha</b>				<b>80</b>

Note: Another 10 % (according to the afforestation formula) of the extra planting material for the forest edge and in empty places were supplemented with - fruit trees (apple, apricot, prunus, sour cherry, pears sorbus and others).

We can see that the judicious establishment of methods and procedures for eco-logical reconstruction of stands, is the foundation on which depends the success and efficiency of each intervention and the work as a whole.

Also, in order to achieve a stable success of the ecological reconstruction works expected in the forests within the Singerei Forest District, it is necessary to harmoniously combine the forestry works with appropriate agrotechnical measures.

*Table 3*

Ecological reconstruction works, strengthening of the state forestry sectors and cantons in the Singerei Forest District performed so far

Forest canton number	The plots in the forest canton	Surface, ha
28	1-4, 7, 9, 11-13	196.72
31	25-26, 31-35, 37-46	413.57
32	36, 47-50, 58-59, 64	400.07
33	51-53, 61	252.87
34	54-57, 63	265.49
35	60, 62, 65-67, 70-71	269.67
36	69, 72-75	306.46
37	68, 76-79, 86	270.89
38	8, 80-85, 87-94	448.63
TOTAL – on the Singerei Forest District		<b>2824.34</b>

## CONCLUSIONS

In the last two centuries, the forest stand, in the study region of the Singerei Forest District, has been intensely modified. Their surface initially decreased drastically, after which there is an increase, due to the ecological reconstruction on previously degraded or deforested lands.

However, the degree of afforestation of the entire country is 13.2 %, being one of the lowest in Europe, 2.3 times lower than the global average and about 3 times lower than the European level.

Singerei Forest District carried out ecological reconstruction works: in 2018 on an area of 15.1 ha; in 2019 on an area of 55.7 ha; in 2020 on an area of 74.3 ha; in 2021 in the spring on an area of 24.4 ha and the autumn works are to be carried out in November.

The ecological reconstruction so far has been carried out on an area of 2824.34 ha compared to the total forest fund which is 11546 ha. We state that the degree of af-forestation in the Singerei Forest District is 11.2 %.

The seasonal conditions and the ecological reconstruction work in which the stands of the Singerei Forest District are located are favorable for the development of some the trees are very productive and highly protective.

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Received: March 22, 2022

Revised: April 12, 2022

Accepted and published online: May 30, 2022