Forest Landscape Restoration in the Republic of Moldova

Feasibility study on the production of forest reproductive material

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Disclaimer

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Cover photo credit: ©Victor Sfeclă (Forest expansion efforts in the Republic of Moldova).

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Abbreviations

EC	European Commission
EFNA	European Forestry Nursery Association
EU	European Union
EUFORGEN	European Forest Genetic Resources Program
FAO	Food and Agricultural Organization
FHE	Forest and hunting enterprise
FLEG	Forest law enforcement and governance
FRM	Forest reproductive materials
FRMI	Forest Research and Management Institute (in original ICAS)
GoM	Government of Moldova
LPAs	Local Public Authorities
LULUCF	Land Use, Land-Use Change and Forestry
MoE	Ministry of Environment
MOLDSILVA	National Forest Agency Moldsilva
NAMA	National Appropriate Mitigation Action: Afforestation of Degraded Land, Riverside Areas and Protection Belts in the Republic of Moldova, United Nations Development Programme
NARP	The National Afforestation and Reforestation Programme for the period of 2023 – 2032
NCFGS	National Centre for Forest Genetics and Seeds
NGO	Non-Governmental Organizations
NFF	National Forest Fund
NTFP	Non-timber forest products
PA	Protected area
SFE	State Forest Enterprise
OECD	Organisation for Economic Co-operation and Development
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNDP	United Nations Development Programme
WB	World Bank
WB PAD Moldova	World Bank Project Appraisal Document Moldova - Climate Adaptation Project
WWF	World Wide Fund for Nature

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Executive summary

The Republic of Moldova has one of the lowest the forest covers in Europe with only 461.6 thousand ha, or slightly more than 11% of the total land area. While several national strategic plans and policy documents set the targets for further forest area expansion to 15-17%, and numerous afforestation projects, leading to a constant increase of the forest area from 1990 to 2020 by more than 60 thousand ha, these targets have been met only partially in the last two decades.

At the end of 2021, the Presidency of the Republic of Moldova formally announced the National Afforestation and Reforestation Programme (NARP) for 2023 – 2032. The NARP has set the ambitious target to increase the forest area by 100 thousand ha by 2032, including 66 thousand ha of new forest plantations, 10 thousand ha of shelterbelts (riparian and for agricultural land protection), and 24 thousand ha rehabilitated forestlands requiring reconstruction or reforestation. Most of the afforestation measures are foreseen on communal lands (Local Public Authorities - LPAs) (61%), but also on private (27%) and state lands (12%).

The critical elements determining the feasibility and success of NARP are, the willingness to change the land use from agriculture to forest plantations and, the capacity to produce large quantities of forest reproductive material (FRM) for the envisaged afforestation projects. In fact, a lack of synergies between the strategic planning for afforestation and technical planning for FRM production can cause significant bottlenecks in achieving the assumed NARP targets.

To address these critical elements, in 2021, the Republic of Moldova approached the United Nations Economic Commission for Europe (UNECE) for support to draft a study aimed to assess the sector of forest reproductive material in the Republic of Moldova. In response to this request, the UNECE drafted a feasibility study on the production of FRM in the Republic of Moldova. The objective of the latter was the assessment of the current production capacity of FRM and perspectives for its development within the context of the national plans for afforestation and forest landscape restoration.

The study was carried out in 2022-2023. The preparatory phase in 2022 included a detailed analysis of the legal acts, strategies and programmes, technical data and existing statistics, as well as consultations with the decision makers and experts from the sector.

The findings:

- Overall, the study suggests pursuing integrating the NARP strategy specific activities tailored to the EU Forest Strategy general principle of forest expansion (EC, 2021), which is “planting and growing the right tree in the right place and for the right purpose”.
- The “right purpose” in the context of Moldova’s national strategic forest-related documents is the restoration of degraded lands, which have a significant share in the Republic of Moldova. Two additional objectives foreseen in the current development strategies have to be integrated into the strategic planning of NARP: 1) the creation of stable forest ecosystems by restoring forests of the natural species composition, and 2) the creation of fast-growing tree plantations to address the high demand for firewood in rural communities and to tackle the illegal logging.
- The selection of adequate land (“the right place”) needs to rely on a landscape approach to integrate the objectives of the afforestation plans. This approach should be connected with, e.g. land availability for afforestation, the development of forest management plans, the targets for urban afforestation, the social needs for energy, and the connectivity of forest ecosystems patches.

- Additionally, the sustainable management of forests originating from the natural forest expansion on agricultural land can be supported by appropriate policy instruments such as: (i) legal recognition of agricultural lands with forest vegetation as forests, (ii) financing forestry measures in young stands' management (e.g. supplementary plantation, cleaning, pre-thinning) and (iii) subsidy schemes for private owners and Local Public Authorities (LPAs) to compensate for their agricultural revenue lost and to pay for the forest ecosystem services provided.
- The selection of appropriate species ("the right trees") helps to create healthy and resilient ecosystems adapted to climate change. A significant challenge is finding species that can meet both, the owners' expectations and the forest restoration objectives. Considering biomass for energy as an attractive investment, most landowners will favour fast-growing species (e.g. black locust), which would not always meet the environmental demands. One approach is to create afforestation mechanisms where e.g. forest restoration receives higher subsidies compared to the fast-growing tree plantations. In these cases, the FRM production would directly be addressed by a set of strategic decisions, e.g. to set up the yearly production capacities for the required species assortments.

The Republic of Moldova has a large area of tree nurseries compared to its forest area, allowing it to cover or even exceed the internal need for the FRM. As of 2022, within Moldsilva Agency, 57 nurseries covered a total area of 962.3 ha, producing mainly bare root seedlings. Nevertheless, the shortage of financial support for technical advances have led to reduced efficiency in the production of FRM in Moldavian nurseries. As a result, the produced annual sapling quantity decreased from 59 thousand in 2006 to 13 thousand in 2017. This decline is mainly caused by low or deprecated mechanization and a labour force shortage.

To achieve the NARP objectives, it is estimated that 48 million seedlings are needed annually. Adding the FRM needs for regular forest regeneration, in total 66 to 80 million seedlings should be produced every year. The existing nursery network has been able to provide these quantities e.g. in 2004 81.5 million or in 2006 66.2 million, though in much less diverse sets of species than needed by the NARP. Overall, the seedling production has drastically dropped in the last decade, with current nursery conditions being inadequate. Most forest nurseries are small and need better production infrastructure, new production systems and technologies.

Therefore, the species assortment produced in the nurseries and the quality of the seedlings requires improvements. For example, currently black locust represents about half of the FRM production. The concept note for NARP implementation proposes using native species on about 56% of the area to be planted. Meeting this objective would require the diversification of the species composition of the currently produced seedlings, particularly the share of those of native origin. However, producing sufficient and good-quality reproductive material has become challenging, considering the constraints of the current production technologies. For example, oak species currently represent 10% of the FRM production while the estimated need is three times higher.

These limitations can be overcome by introducing innovative techniques, re-organization, modernization, and privatization of forest nurseries. The main challenge in FRM production is to change the current approach by centralizing FRM production in three main industrial centres. While efforts have already been made to identify their optimal location based on a set of economic and efficiency indicators, important organizational and logistic investments are needed which require funds and political support.

The technical planning of the FRM production in the industrial centres and the existing nursery network will have to (i) provide at least 3-5 million containerized seedlings in the next five years, (ii) install modern irrigation systems for efficient water use, (iii) review the production technologies to deliver the adequate

species, and (iv) provide qualified personnel in the nurseries and the field with training on the new methods and technologies.

The study identifies the key missing elements in the current system, provides recommendations, and indicates concrete next steps for the development of the sector on forest restoration and FRM production in the Republic of Moldova.

The main improvements recommended include:

- Developing the FRM sector tightly linked with the overall NARP strategy by setting clear area targets for each of the policy objectives: afforestation of degraded lands, restoration of existing ecosystems, forest plantations for energy purposes, and urban and peri-urban forests.
- Developing further the NARP strategy to encompass more detailed activities. The landscape planning approach should be connected with e.g., land available for afforestation, the provisions of forest management plans, the social needs etc. with given hierarchical priorities e.g. depending on urgency, expected benefit, effect/cost factor, probability of success, etc.
- Implementing the NARP in a comprehensive and consecutive way, with an adaptable pace, and adjusted to available resources. The plan has to cover the whole chain of production with its main components e.g. availability of land, proper planning (function, species composition), availability of seeds, seedling production capacity, planting capacity, and financial and technical support to landowners.
- Concentrating resources and efforts and selecting smaller-scale but stable, well-funded and supported projects to improve efficiency, success and sustainability of the measures undertaken, and serving as examples for good practice and knowledge-sharing.
- Carrying out the technical planning of FRM development, based on an in-depth cost-benefit assessment with an improved set of indicators, to identify the efficiency of the existing network of nurseries and to establish industrial centres for FRM production.

There is a significant political and societal interest in afforestation activities in the Republic of Moldova. However, further development and implementation of National Afforestation and Reforestation Plan requires a comprehensive approach, and common support by the decision-making and technical planning entities as well as, engaging with stakeholders beyond traditional forest sector.

1. Introduction

1.1 Context of the study

At the end of 2021, the Republic of Moldova announced its National Afforestation and Reforestation Programme (NARP) from 2023 to 2032. The program aims to restore forest areas on the national territory for the next ten years, as well as to increase the quality of forest ecosystems. The primary goal is to ensure the multiple benefits of forest ecosystems in the long-term. In addition, it includes addressing forest dependent livelihoods, halting land degradation and soil erosion, maintaining, and preserving forest biodiversity, and safeguarding the essential hydrologic regime. This presumes direct activities on selective afforestation/reforestation, ecological regeneration, ecosystem reconstruction, forest rehabilitation (including reliance on native species that are much more adapted to climate change), as well as on adaptive management to control the use of non-native species that have long existed in the country and demonstrate higher productivity.

In the context of the massive afforestation actions, expected to start in 2023, there is an urgent need to improve technical capacities to produce forest reproductive material (FRM) in the country. One of the prerequisites for addressing this need is to increase the availability of planting material to improve forests' quality and resistance to unfavourable environmental factors such as air, water, or soil pollution. Strengthening the quantity and the quality of the production capacity of planting material is particularly needed, as it guarantees sustainable forest expansion and successful forest landscape restoration.

To address these critical elements, in 2021, the Republic of Moldova approached the United Nations Economic Commission for Europe (UNECE) for support to draft a study aimed to assess the growth sector of forest reproductive material in the Republic of Moldova. In response to this request, the UNECE drafted a feasibility study on the production of FRM in the Republic of Moldova. The objective of the latter was the assessment of the current production capacity of FRM and perspectives for its development within the context of the national plans for afforestation and forest landscape restoration.

1.2 Data sources, methodology, timeline

Within the project framework, the study was produced in consultation with national experts from the Republic of Moldova, based on the analysis of relevant information, legislations, policies and technical guidelines. Documents were made available by the relevant national authorities. In addition, data and inputs for this study were collected from publications of United Nations (UN) entities, in particular of the United Nations Food and Agriculture Organization (FAO), as well as available statistical data, governmental documents and reports. When relevant, these studies are referenced in footnotes.

A working group was set up with the relevant actors from the forestry sector: the representatives of the Ministry of Environment (MoE) of the Republic of Moldova, the representatives of the National Forest Agency Moldsilva (the main administrator of the forest nursery network) and the representatives of the Forest Research and Management Institute (FRMI). Two meetings were organized with the group members. The first meeting of the working group was held on the 23 of December 2021 and intended to decide on the relevant data types and sources for the report. Requests for information on the production capacities of the existing nurseries were sent to the Moldsilva Agency. In addition, the FRMI was approached for an update on the existing forest genetic materials and on the ongoing projects with relevance to the study. The FRMI provided the data for the production capacities of the nurseries in 2017 and a draft version of the updated study for 2021. These studies were used to assess the existing FRM production capacities. The meeting on the 27 of February 2022 was held in the presence of the State Secretary of MoE and focused on identifying the current policy goals for afforestation and the impact on the development of FRM production.

The draft version of the report was sent for internal consultation with the experts involved in the working group on the 24 of October 2022.

2. Forests and the forest sector in the Republic of Moldova

2.1. Overview of forests, trees outside forests

2.1.1. Definition of forests and of the National Forest Fund

The Forest Code of the Republic of Moldova (1996) defines forests as land areas covered by forest vegetation, characterized by trees and shrubs, naturally or artificially regenerated creating a specific biological environment on a minimum of 0.25 ha and are included in the National Forest Fund (*fond forestier national*). The national definition of forests does not make specific references to canopy coverage and tree height, as does FAO´s international definition. Thus, data comparison among countries has to acknowledge the differences in definitions. There are no results of a National Forest Inventory that could provide data on forest areas considering the FAO definition.

The Forest Code (1996) also defines the notion of the National Forest Fund (NFF) of the Republic of Moldova. The NFF is composed of forests, lands meant for afforestation and other land designated as forest by the existing legal frame. The NFF includes all forests, regardless of the ownership form or administrative structure. However, part of the forest plantations done on the land of Local Public Authorities (LPAs) or private lands are not integrated into the NFF and are still statistically considered agricultural lands. Clarifications on the official procedures and responsibilities required for the integration of afforested lands into NFF are needed in this case.

The forest vegetation outside NFF consists mainly of protective forests belts and shrubs that may be considered trees outside the forest according to the FAO definition.

2.1.2. Data regarding forest cover, NFF areas and trees outside forests

The values on forest cover reported for the Global Forest Resource Assessment (FRA)[1] by the FAO and the Joint Pan-European Data Collection [2] of UNECE, FAO and Forest Europe consider that in 2020 there were 386.5 thousand ha of forests with an additional 75.1 thousand ha of other wooded lands. The total of forests and other wooded lands is reported to be 461.6 thousand ha.

Data at the country level may be slightly different considering the different reporting by national agencies. According to the National Statistical Office of the Republic of Moldova[3], the forest lands and those for environmental protection in 2020 count an area of 452.3 thousand ha and the NFF of 425.4 thousand ha. According to the same source, the area of forests is 381.8 thousand ha.

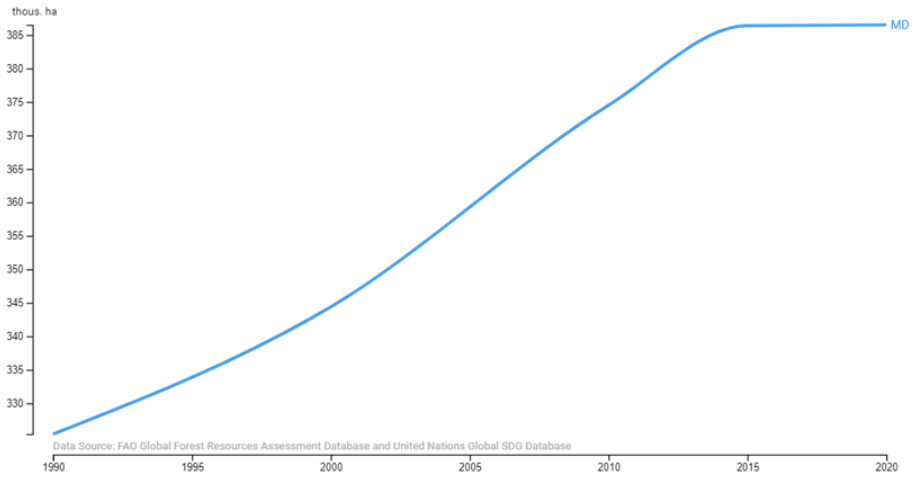
Based on the data from National Cadastre in 2021, the NFF is considered to be 449.8 thousand ha out of each 370.1 thousand ha are forests, according to the national definition (table 1). The share of forest area is slightly more than 11% of the total land area, being relatively low compared with the European average. The forest area has constantly increased from 1990 to 2020 with more than 60 thousand ha, mainly as an outcome of different afforestation projects (figure 1).

According to the data from National Cadastre[4], in 01.01.2021 the forest vegetation outside NFF was 50.7 thousand ha, represented by forest shelterbelts (30.2 thousand ha) and shrubby vegetation (20.5 thousand ha). Forest shelterbelts constitute 1.22% of the area of agricultural lands, the majority (79.4%) belongs to

[1] https://www.fao.org/forest-resources-assessment/fra-2020/country-reports/en/
[2] https://fra-data.fao.org/MDA/panEuropean/forestArea/
[3] https://statbank.statistica.md/pxweb/pxweb/ro/10%20Mediul%20inconjurator/10%20Mediul%20inconjurator__MED050/?rxid=b2ff27d7-0b96-43c9-934b-42e1a2a9a774
[4] https://www.legis.md/cautare/getResults?doc_id=126208&lang=ro

public property of LPAs representing 40.4 thousand ha. The main species in forest belts are walnut (38%) and non-native black locust (36%).

Figure 1. Evolution of forests areas from 1990– 2020

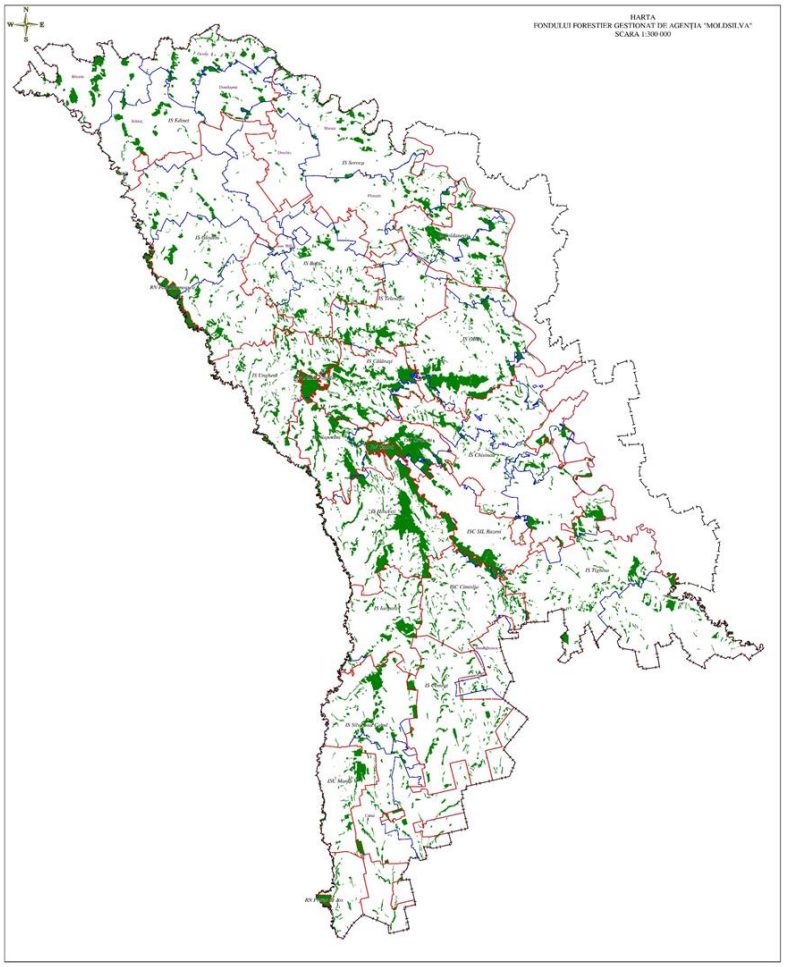


2.1.3. Data regarding forest characteristics

Forests are predominantly present in hilly areas. Most forests is located in the central part of Moldova (so-called "Codrii" region). Slightly fewer forests are present in the north and even fewer in the south of the country (figure 2).

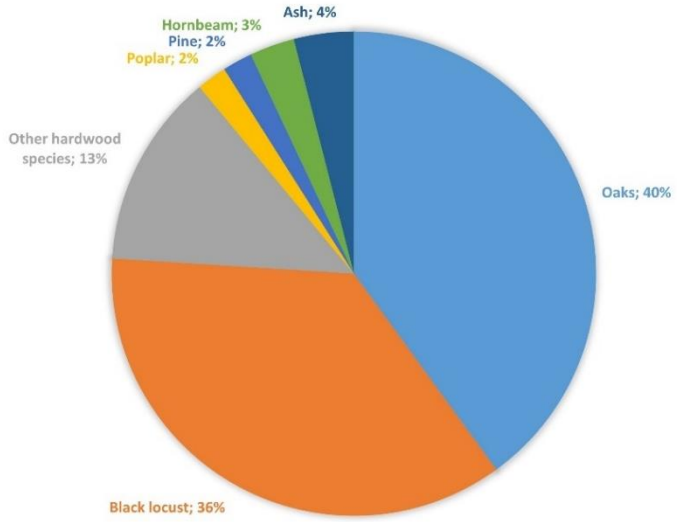
The forests are mainly broadleaved (oak, ash, hornbeam, black locust and poplar are the most significant species) with planted non-native conifers accounting for just 2% of the forest area (figure 3). Oak-type forests, which have historically been the most common forest type in the country, cover currently only 44% of the forestland. Nowadays, only 27% of oak stands are regenerated from seeds (i.e. of generative origin), while the rest are regenerated from sprouts (i.e. vegetative origin) as a result of former intense coppice management.

Figure 2. Map of the forest areas in the Republic of Moldova



Source: FRMI

Figure 3. Species composition



Source: Moldsilva Agency

The second biggest forest type is represented by black locust (*Robinia pseudocacia*) which covers 36% of the forestland. Black locust was largely used for afforestation projects on marginal lands and it is considered almost naturalized and increasingly preferred by households or landowners for its benefits (fuelwood, erosion halter, beekeeping, tea, other food etc.). Except in a few communities, most of the community forests are young forest plantations of black locust created after 2002[5] or earlier.

A large percentage of the mature forests stands lack the genetic and species composition of healthy forest ecosystems[6]. Thus, rehabilitation of existing forest stands is also highlighted as a priority in the current programmatic documents[7].

Climate change is expected to further reduce the productivity of natural forests. According to the WB PAD Moldova Climate Adaptation Project (2017)[8], the key climate change impacts up to 2050 are forecasted to limit the growth of tree species due to a (i) decrease in water availability and an (ii) increase of the areas affected by pests (by 15%). Furthermore, forest areas are affected by drought (by 25%) and fire risk (by 30%), as well as (iii) soil erosion as a result of temperature increase, changes in precipitation and a reduction in year-round water availability. According to the same assessment, different tree species will react differently to these new conditions, but native oak species are expected to adapt better than non-native species.

2.1.4. Data regarding the use of forest resources

According to the Forest Code (1996), the main function of forests is the protection of the environment. Thus, all forests are considered primarily to have protective functions and additional production functions. There are five protection subcategories: water protection (assigned as the main function for 1.6% of the forest area in the category of protected area), soil and land protection (7.9%), climatic and industrial damaging factors protection (47.4%), recreational (26.4%) and scientific interest or genetic resources protection (16.7%).

The total growing stock is 46 million m^3 or 124 m^3/ha. The average age of the forest is 40 years. The total annual increment is 1 251 thousand m^3 (or 3.3 m^3/ha average). The annual allowable cut, according to the forest management plans valid in 2021, is 697 thousand m^3/year, out of each 623.9 thousand m^3/year are from the forests administrated by Moldsilva Agency and 73.6 thousand m^3/year from forests belonging to

[5] The 60000 ha of forests officially announced to be created from 2022 to 2010 were created on out-of-use lands, mainly using black locust as the main species (https://www.worldbank.org/en/results/2013/08/08/moldova-more-trees-means-more-food).

[6] UNDP, 2016: https://www.uncclearn.org/resources/library/nama-on-afforestation-of-degraded-land-riverside-areas-and-protection-belts-in-the-republic-of-moldova/

[7] Governmental action plan 2021-2022, National Plan for the expansion of forest vegetation 2022-2030, https://particip.gov.md/ro/download_attachment/14911

[8] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/617551497232845961/moldova-climate-adaptation-project

other owners (mainly LPAs). From 2016 to 2020, the average harvested volume reported by Moldsilva Agency was 573.6 thousand m^3/year.

Forests are an essential source of fuel and energy for local populations. Firewood consumption represents more than 90% of the legally harvested timber. Nevertheless, the annual fuelwood consumption is estimated, as three times the officially reported firewood sales[9]. Thus, forests are under increasing pressure from several sources, including illegal felling (mainly for fuelwood) and poor wildlife management (mainly abusive and illegal hunting). Harvesting non-timber forest products (NTFPs) is an important activity undertaken by private households (community members) and entities within the Moldsilva Agency.

2.2. Overview of the organization of forest management in Moldova

2.2.1. Forest ownership

According to the data recorded by the National General Cadastre Registry[10] (01.01.2021) the NFF of the Republic of Moldova represents 13.6% of the total land area of the country; 80.7% of the NFF is owned by the State (through Moldsilva Agency and its network of forest units), 18.7% by Local Public Authorities (LPAs) and 0.6% is private ownership (table 1)

Table 1: Structure of forest land ownership

Category of owners	Total national forest fund area in '000 ha (%)	Area covered with forests in '000 ha (%)	Area covered with other forest vegetation '000 ha (%)
National forest fund under state public property	362.8 (80.7)	317.7 (85.7)	9.8 (19.4)
National forest fund under communal public ownership (community forests)	84.3 (18.7)	50.5 (13.6)	40.3 (79.3)
National forest fund under private ownership	2.7 (0.6)	2.5 (0.7)	0.6 (1.3)
Total	449.8 (100)	370.7 (100)	50.8 (100)

Source: National General Cadaster Registry, 01.01.2021

According to the same data sources, 370 LPAs have a total area of 84 thousand ha of land included in the NFF with a resulting average size of the estates of 227 ha. The lands included in private ownership represent 2744 ha recorded for 4464 private owners with an average size of 0,6 ha.

Besides forests and other wooded lands, the NFF also includes other types of lands. Thus, the repartition of forest ownership is not the same as for all the lands included in NFF. The National Cadaster records that 85.7% of the forests are owned by the State, 13.6% of the forests are owned by LPAs and 0.7% of the forests by private forest owners (table 1).

In addition, many forest plantations on private lands and LPAs are recorded as agricultural land and are not included in the NFF (and official statistics) as forests or other wooded lands. This has implications for their sustainable management. Therefore, a clarification of the legal procedures/status of "hanging forest vegetation" and its further inclusion into NFF is needed.

[9] ENPI (2011): Moldovan Forests - Wood Harvesting and Consumption, May 2011. Report prepared under the ENPI FLEG, World Bank
[10] https://www.legis.md/cautare/getResults?doc_id=126208&lang=ro

2.2.2. Lands with soil erosion and degradation

Soil erosion is a major environmental problem in the Republic of Moldova. Article 2 of the Law on the improvement of degraded land through afforestation (Law no. 1041 from Jun. 15, 2000[11]) defines degraded land as land that has permanently lost its agricultural productive capacity through erosion, pollution or destructive anthropogenic activity, but can be improved through afforestation and other measures that restore its ecosystem services.

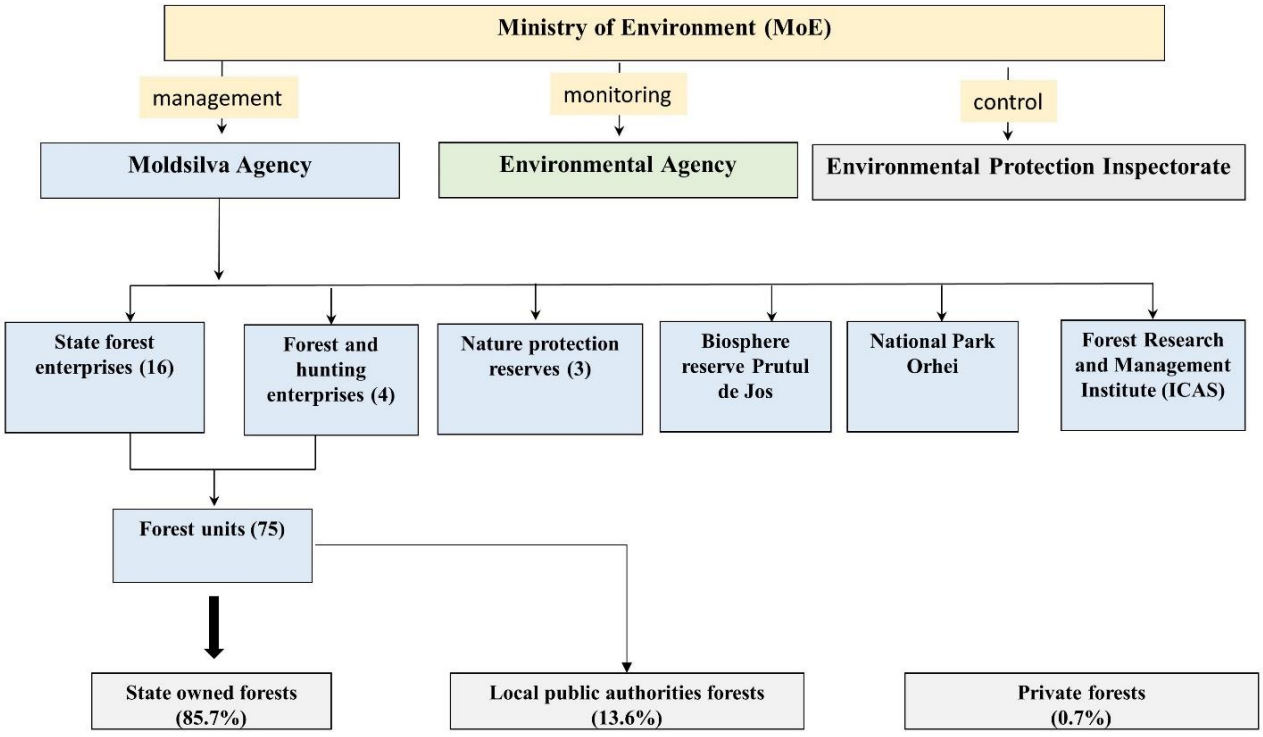
According to the arguments put forward for the approval of the National Plan for Land Improvement[12], in 2008 about 877 thousand ha were considered eroded lands (45% of the total arable land), while in 2019 the area of eroded lands increased up to 1 015 thousand ha (55% of the current level of arable land). Thus, over the last decade, the area of eroded land increased by 16%. More than 140 thousand ha are considered highly eroded. Most of these lands are under private or communal (LPAs) ownership.

Pastures (land suitable for hay and grazing) occupies 14% of the total land used for agriculture. Signs of land degradation are seen in many pasturelands and nearly half of them (48%) is directly affected by different unsustainable uses or practices. The current productivity of pasturelands has been estimated at 20-50% of its potential. Abusive and uncontrolled grazing as well as direct waste pollution are the main factors contributing to the degradation rate.

2.2.3. Institutional framework

The current forest institutional framework in the country includes the national policy authority, which is the Ministry of Environment (MoE) with subordinated institutions: Environmental Agency, Environmental Protection Inspectorate and Moldsilva Agency, as well as LPAs owning/managing forests (figure 4).

Figure 4. The institutional framework of the forest sector in the Republic of Moldova



[11] https://lege.md/act/pentru_ameliorarea_prin_impadurire_a_terenurilor_degradate
[12] https://gov.md/sites/default/files/document/attachments/subiect-04_3.pdf

Source: Moldsilva Agency[13]

The Ministry of Environment (MoE) is the state authority responsible for developing and promoting policies and strategies addressing environmental protection, rational use of natural resources and biodiversity conservation. It directly coordinates the activity of:

- Moldsilva Agency, in charge of forest policy enforcement and forest management;
- the Environmental Agency, issuing authorizations for the use of natural resources; and
- the Environmental Protection Inspectorate, responsible for enforcing environmental legislation (including in forests, protected areas, and forest nurseries).

Moldsilva Agency manages nearly 80% of the total country's forestland. Moldsilva Agency is a network of as many as 25 state forest enterprises (SFEs) through 75 forest units under the SFEs. Its institutional structure is as follows:

- a headquarter (only for administrative management and coordination);
- 24 State entities composed of, 16 SFEs, 4 state forest-hunting enterprises, and 4 nature reserves;
- Forest Research and Management Institute (ICAS);
- Protection areas (PA).

Protection areas are umbrella entities encompassing both forest/hunting units and other properties (local, private etc.), namely one biosphere reserve (Lower Prut) and two national parks (Orhei and Lower Nistru). The newly created PA categories are still not functional as conservation bodies, so further projects will have to focus on enhancing their capacities and improving forest/pasture/water management.

The forest units of Moldsilva Agency are the main providers of wood for energy (and other household needs) for the local population. To ensure wood distribution from the first place in the value chain, the forest units of Moldsilva Agency undertake harvesting on their own and sell the wood/timber directly to customers according to an approved price catalogue (per species and hard/soft categorization). Most of the wood supplied to the market is fuelwood (90%), while the timber is much less (up to 10%). In general, the wood demand is not met by the supply, thus a fuelwood shortage is visibly growing (especially during the 2021-2022 energy crisis). Moreover, it hardly meets the population's needs in various products. Thus, Moldsilva Agency tries to cope with both regulatory and management functions to balance the socioeconomic demand. Being the manager of strategic resources (primarily wood, NTFP, game etc.), Moldsilva Agency is an authority institution with increased challenges for institutional transformation and optimization based on sustainable forest management principles.

Local Public Authorities (LPAs) have legal obligations towards respecting the forest regime, as legally all the owners have to according to the Forest Code, and specifically of the management of their forests. This includes organizing and coordinating the use, management, regeneration and protection of forest vegetation under their administration. There is no institutional body that either administers or undertakes coordination over forests outside Moldsilva Agency (forests which are mainly owned by LPAs), although the legal frame stipulates clear equal principles for all forestland owners regardless their origin or condition. Given the experience and authority in the sector of Moldsilva Agency, the regulatory framework encourages LPAs and private forest owners to cooperate with the entities subordinated to Moldsilva Agency to maintain and promote forest vegetation.

[13] http://www.moldsilva.gov.md/public/files/Organigrama.PDF

The management of communal forest varies (representing 13.6% of national forests). Some LPAs have adopted traditional collective management, e.g. Boghenii-Noi or Sinesti, communes that own both natural forests and plantation. Others are trying to find ways through institutionalizing tools or establishing municipal enterprises specialized in providing forest management services among other public services. The communal council of the LPA determines the right of use over forest products, according to forest management plans. The management plans are developed by Moldsilva Agency through the FMRI as part of assistance to local communities and mostly through international projects (e.g. under assistance of the European Union (EU), the World Bank (WB), the United Nations Development Programme (UNDP) etc.). So far, only 25% of the communal forests have forest management plans. Most communal councils do not have enough financial resources and human capacities for proper forest management or law enforcement, which puts these forests at risk of illegal logging. Nearly 20 thousand ha of the LPA's forests are somewhat guarded by Moldsilva's units as part of the Agency's duty to assist other forestland owners. Most of these forests resulted from the LPAs involvement in common projects (e.g. afforestation, carbon sequestration, ecosystems rehabilitation etc.).

To increase the interest of LPAs and private owners to either create new forest plantations or enhance existing spontaneous forest vegetation, legal and financial adjustments need to be undertaken by authorities to fill the gaps in their forest administration and management.

2.3. Overview of the forestry regulatory framework

The national forestry sector is regulated by about 20 laws, several government regulations, and policy documents (Box 1).

Box 1: Main legal acts and policy documents relevant to the forestry sector of the Republic of Moldova

Laws:

- Land Code no. 828-XII from 25 December 1991;
- Forest Code no. 887-XIII from 21 July 1996;
- Law no. 1041-XIV from 15 June 2000 on amelioration through afforestation of degraded lands;
- Law no. 91-XVI from 5 April 2007 on public property lands and their delimitation;
- Law no. 44/ 2022 on the production, trade and use of forest reproductive material in Moldova.

Policy documents:

- Strategy on sustainable development of forestry sector in Moldova (Parliament Decision No. 350/2001);
- Environmental protection strategy of Moldova (Governmental Decision (GD) No. 301/ 24.04.2014);
- Moldova's climate change adaptation strategy (GD No. 1009 / 10.12.2014);
- Moldova's biodiversity conservation strategy (GD No. 274 / 8.05.2015);
- Moldova's low emissions development strategy (GD No. 1470 / 30.12.2016);
- The strategy of institutional reform of the forestry sector in Moldova (2012-2019, draft);
- Forestry sector's climate change adaptation strategy (draft, 2015-2018)

The main policy document approved by the parliament is the "Strategy for the sustainable development of the forestry sector" (No. 350-XV from 12.07.2001)[14]. A detailed action plan for implementing the Strategy

[14] https://www.legis.md/cautare/getResults?doc_id=63247&lang=ro

was first approved in 2003 (No. 739 from 17.06.2003[15]) but then revoked by the GoM in 2012. The Strategy explicitly called for the "integration of forest activities in the complex of national and regional strategies and programs". However, the document is currently outdated and discussions on its renewal are undergoing.

The main legal document of the forestry sector is the Forest Code adopted in 1996 (Parliament Law nr. 887 from 21.06.1996 and entered into force on 16.01.1997[16]), with later amendments from 2001, 2003, 2005, 2009, 2011 and 2013. A new version of the Forest Code was developed during the EU FLEG programme (2010-2014) and a bill was prepared and put under parliamentary approval in 2019, however, rejected by specialized commissions. In 2022, the Ministry of Environment (MoE) created a working group to review and update/adjust the Forest Code to new environmental challenges and socio-economic conditions.

The existing legal framework encourages the expansion of areas covered with forest vegetation through the afforestation of degraded land and the restoration and extension of protection forest belts in agricultural systems and along riparian zones. However, according to different forest policy analyses[17], the Forest Code still requires improvement to fill the gaps in administration of forests and embrace all stakeholders needs, including land or ecosystem degradation and the country's preparedness for times of energy crisis. According to the author, the Forest Code has to clearly define the institutional and technical aspects of forest ownership along with a common understanding of the actions to be undertaken to maintain, augment and ensure sustainability over the whole forest resources of the country, regardless of forest origin or ownership.

[15] https://www.legis.md/cautare/getResults?doc_id=29562&lang=ro

[16] https://www.legis.md/cautare/getResults?doc_id=118482&lang=ro

[17] Lozan and Rotaru, 2015, Republic of Moldova: comparative analysis of the national forest legislation with the international legal framework for ensuring an efficient management of forest resources, ENPI-FLEG

3. European approaches to reforestation, afforestation and forest landscape restoration

3.1. EU Forest Strategy 2030

The new EU Forest Strategy (2021)[18] recognizes a broader range of climate and socio-economic functions of forests. Establishing robust and resilient new forests requires the consideration of the new EU Biodiversity Strategy for 2030 (2020) and the EU LULUCF Regulations (2018). Limiting the effects of climate change, increasing biodiversity, and ensuring resilient and multifunctional ecosystems with long-term carbon sequestration are the main objectives for establishing new forest areas.

The main elements with a direct impact on the increase of forest area stipulated in the new European forest strategy are:

- ensuring forest restoration and strengthening sustainable forest management to adapt to climate change and increase forest resilience;
- develop guidelines on biodiversity-friendly afforestation and reforestation;
- reforestation and afforestation to create forests with rich biodiversity;
- providing financial incentives for forest owners and managers to improve the quantity and quality of forests in the EU.

The objective proposed at the EU level is to plant 3 billion trees by 2030, in full compliance with ecological principles, to balance greenhouse gas emissions. The general principle of the strategy is **planting and growing the right tree in the right place and for the right purpose.**

The roadmap for implementing this target sets out clear criteria for tree planting, counting and monitoring. A special focus is set on a strong monitoring component to track progress towards achieving the target. Urban and peri-urban areas are mainly targeted for afforestation purposes (including e.g. urban parks, trees on public and private property and urban gardens) along with agricultural areas (including e.g. in abandoned areas as well as through agroforestry and silvopasture, landscape features and the establishment of ecological corridors).

The EU Forest Strategy also makes direct references to the need to produce large quantities of appropriate FRM to ensure the adaptation of forests to climate change and the restoration of future forest degradation. The European Commission intends to revise the legislation on FRM with measures to **promote the production of FRM suitable for future climatic conditions**. The revision aims:

- to secure and increase the availability and the sustainable use of the genetic resources on which a more climate-proof forestry depends;
- to support research and provide better information on the production of FRM for future climatic conditions and to assist forest species migration;
- to enhance the collaborative production of FRM and its transfer across national borders.

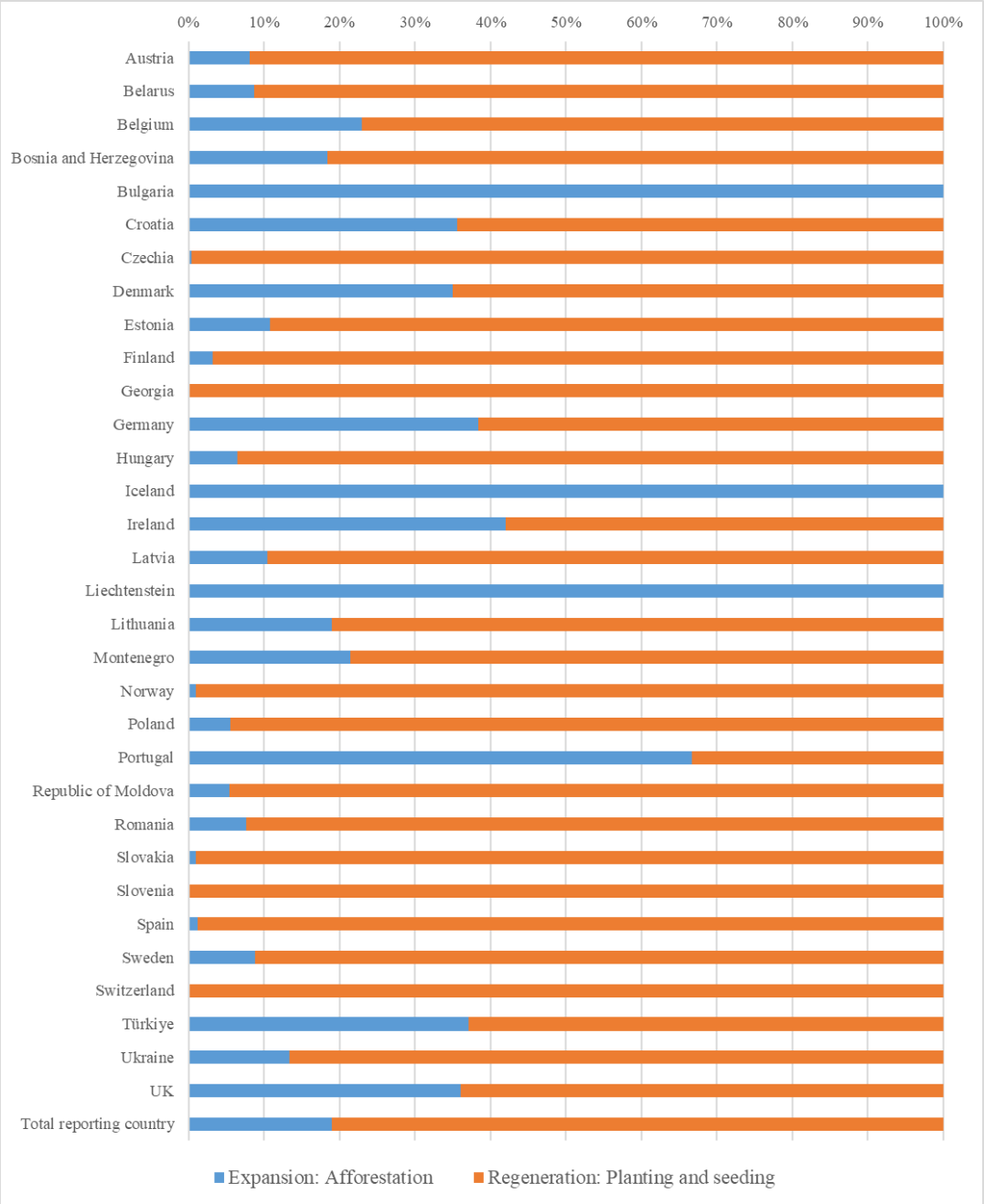
The Republic of Moldova in not a Member State of the EU but currently has the candidate status. Thus, considering the policy efforts of the Republic of Moldova for the integration with the EU legal framework, the objectives of the EU Forest Strategy 2030 can serve as guidance for the strategic planning of the national afforestation programs.

[18] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0572

3.2. Forest regeneration and expansion in Europe

The State of European Forests 2020 report[19] uses indicators to characterise the forest area by stand origin and by types of forest regeneration and expansion. Forest regeneration is, by definition, clearly distinguished from forest expansion. Forest regeneration means the re-establishment of a forest stand and can occur either naturally through natural seeding or coppice sprouting or artificially by planting or artificial seeding. On the other side, forest expansion is the increase of forest area at the expense of land that was previously used for other purposes. Natural forest expansion refers to the forest establishment through natural succession while afforestation is actively pursued by either planting or deliberate seeding.

Figure 5. The main use of artificial regeneration in Europe (2015)



Source: Joint Pan-European Data Collection[20]

[19] https://foresteurope.org/state-europes-forests-2020/

[20] https://fra-data.fao.org/FE/panEuropean/annualForestExpansionAndRegeneration/

About 66% of the total forest area in Europe originates in natural regeneration or natural expansion[21]. For example, countries like Norway, Slovenia, Croatia and Estonia report that natural expansion and regeneration are at the origin of more than 90% of their forests. On the other hand, the Republic of Moldova reports that only 43% of their forests are of natural origin.

The proportion of forests established by afforestation through planting and/or seeding above 60% are found in eight countries, namely Belgium, the Czech Republic, Denmark, Iceland, Ireland, Poland, The Netherlands and the United Kingdom.

In 2015, at the European level, artificial regeneration was used on 871.22 thousand ha, with planting and seeding of existing forest stands representing 82% while forest expansion by afforestation accounts for 18% (figure 5)[22]. Thus, in most European countries, the production of FRM is mainly done to re-establish existing stands. Nevertheless, in Iceland and Bulgaria, artificial regeneration is reported to be used only for forest expansion while Portugal, Ireland, Turkey, Croatia and Denmark report percentages above 35% in the use of artificial regeneration for forest expansion.

3.3. FRM production and the region of provenance

The FRM regulations are provided by the European Directive 1999/105/EC and ensure that traceability of the planting stock during the collection and production process to a registered source of basic material. Furthermore, it provides information on the source location (region of provenance) and the genetic quality of the stock.

The EC Directive 1999/105 warrants the steady supply of high-quality FRM, by specifying that FRM may not be marketed unless it is classified under one of four categories defined by the EC Directive. Additionally, the EC Directive specifies that only the approved basic material of the original trees from which FRM is harvested, may be used for marketed FRM production. Information on FRM approved by a State is stored in a national register. The Directive uses the concept of "region of provenance", areas within similar ecological and climatic characteristics. These regions designate areas in which stands or seed sources presenting similar phenotypic or genetic characteristics are found for a species.

Most of the former centrally planned economy countries joined the OECD Scheme for the Certification of Forest Reproductive Material[23] long before joining the EU. Many of these countries had legal systems in place that carefully regulated, by law, the marketing of FRM within the country. Therefore, not many changes of significance were needed to comply fully with the requirements of Directive EU/1999/105. The flexibility of implementing this directive at the State level generally refers to the designation of the regions of provenance, with significant implications related to the use and transfer of the FRM. However, the approaches to its implementation, vary among European countries. In general, countries with a small area and homogenous relief and vegetation conditions prefer to use more simple criteria and mechanisms to identify the regions of provenance, which lead to a small number of such areas.

For example, Romania uses a complex system with climatic, geographic and vegetation criteria and 16 ecological regions overlaid on large geomorphological units for 21 species. The United Kingdom is divided into four regions of provenance. For the native species, the regions of provenance have been split into a total of 24 native seed zones. Sweden is divided into five regions of provenance for all species. The boundaries generally go from east to west, and the regions, reasonably similar in size, are delimited by geomorphological and climatic criteria. In Austria, the delimitation of the regions depends primarily on the natural distribution of the main tree species, with particular consideration being given to climatic

[21] Based on reports from 35 European countries representing more than 95% of Europe's forested area

[22] https://fra-data.fao.org/FE/panEuropean/annualForestExpansionAndRegeneration: based on reports from 30 European countries

[23] https://www.oecd.org/agriculture/forest/

differences. Ecologically similar regions of provenance are grouped in 9 forest regions with 22 sub-regions of provenance. The Czech Republic is divided into 41 regions of provenance for all the main tree species. In the Netherlands, the entire area of the country is considered one region of provenance for all species covered in the FRM Directive. However, the region is divided into eight sub-regions which are further divided into Districts. Every ten years, the Dutch authorities issue a list of provenances recommended for use in forestry. Belgium and Luxembourg use a similar system. Denmark and Ireland have relatively small and homogenous territories. Therefore, only one region of provenance has been identified in these countries. Starting in 2003, France began to use a complex system with 8 regions of provenance. The new system was created to have full compatibility with the EC Directive 1999/105. The French authorities carried out a complete review of all available new research on the distribution of forest genetic characteristics throughout France, employing DNA analysis wherever possible. Finally, they came up with a completely revised system of delimiting and identifying the regions of provenance.

There are also some exceptional cases. For example, in countries with federal structures, such as Germany, Italy or Spain, the FRM framework is defined at the State, not federal level. The review of the approved basic material is recommended at 10 years (in most countries) to 15 years (e.g. Italy). However, in some countries (e.g. Germany), no revision period is indicated. In that particular case, the revision is being done continuously, and the German forest administrations of the federal States provide forest owners with recommendations for using provenances in different regions. In Germany, two certification systems are currently in place: the Certification Scheme for Tracing the Origin of Forest Reproductive Material in Southern Germany (ZüF) and the FfV Certification, supported by the Association of Forest Seeds (ISOGEN). Both systems use a robust framework to verify and trace the origin of FRM from harvesting and seed processing to the seedlings in nurseries. In Italy, regional administrations designate the regions of provenance due to the significant environmental variability of the Italian Peninsula. The maps for each region are disconnected from each other. Therefore, the use of FRM outside a region is quite difficult. Italy also applies special legislation concerning forest tree clones due to the economic value of poplar clones.

3.4. Production capacities in forest nurseries in Europe

Although in the Republic of Moldova, mainly deciduous species are produced in nurseries, experiences of other countries that produce a diversified range of species can be relevant in regards of future climate scenarios showing higher temperature and lesser precipitation patterns across the region.

Production of a steady supply of high-quality FRM depends on both, adopted technologies and the production capacity of forestry nurseries. In Europe, production and trade of coniferous FRM are mainly undertaken by Scandinavia and the Baltic countries, while Central Europe is more reliant on broadleaved species[24]. Many countries trade seeds and seedlings of non-domestic origin in addition to their local FRM production. For example, Germany sells Norway spruce seedlings of Polish and Lithuanian origin; some seedlings are grown in Estonia from Finnish seed and then imported back to Finland.

In Sweden, the Swedish Forest Nursery Association represents more than 95% of the producers of forest seedlings. In 2020 this association delivered to the forests in Sweden over 400 million seedlings[25]. The proportion of containerized seedlings is high in Sweden, about 92%, which displays the interest in this technology and the effect on the production efficiency of FRM[26]. The main part of the seedling production is of coniferous trees, which have a long and rather slow growth cycle both in the nursery and the forest.

[24] Jansen S, Konrad H, Geburek T (2019) Crossing borders – European forest reproductive material moving in trade. Journal of Environmental Management 233: 308-320

[25] Föreningen Sveriges skogsplantproducenter /Swedish Forest Nursery Association. European Commission Feedback reference F2668008, 24 August 2021

[26] Mattsson, A. (2002). Nursery practices in Sweden. In: Dumroese, RK; Riley, LE; Landis, TD, technical coordinators. National proceedings: forest and conservation nursery associations-1999, 2000, and 2001.

There is a growing interest in machinery planting, connected with a situation where labour for planting operations is more difficult to find.

In Finland, the annual need for forestry seeds is 10 000 – 12 000 kg (mostly Scots pine). As stated by the Finnish Food Authority the yearly production of seedlings in Finnish nurseries varies between 155–180 million seedlings[27]. Most nurseries use genetically improved seeds for their production. There are 107 productive seed orchards with a total area of nearly 1 700 ha. They are owned and managed by private companies. In 2016 the 42 nurseries from Finland produced 158 million saplings. The saplings are produced in large modern nurseries with capacities of 10 million plants per year.

In Poland, according to the Central Statistical Office, the area of forest nurseries in 2020 was 1 824 ha, of which 1 801 ha was in the State Forests. The production of seedlings takes place in the field, in containers and in tunnel systems. Nearly 88% of the total production of seedlings comes from field nurseries. In 2020, a total of 750 million seedlings were produced in the Polish State Forests with more than half (50.9%) being seedlings of deciduous species[28].

In the Northern Mediterranean Basin[29], two main types of nursery stock are produced: bare-root stock and container stock, while greenhouse transplant stock is scarce. The use of containerized stock has successfully increased in the last decades at the expense of bare-root stock. In Portugal, more than 90% of nursery stock is produced in containers. Bare-root stock also prevails in Spain and Croatia. Most containerized saplings are produced in private nurseries with the use of modern technologies and adequate irrigation systems. Containers come in a variety of materials, sizes, shapes, and concepts. Large containers are employed when producing planting stock for use in more xeric zones.

In France[30], there are two types of nurseries (regular and authorised) supplying plants of the species listed in the FRM Directive EU/1999/105. Only the authorized nurseries are allowed to sell plants for use for forestry purposes. These authorised nurseries are subjected to rigorous annual inspections by the Regional Directorate for Food, Agriculture and Forestry particularly during the dispatch season and are required to issue supply documents and maintain accurate records for all plants of the species listed in the EC Directive.

At the European level, the overall interests of nursery producers are represented by the European Forestry Nursery Association (EFNA) which represents the views of the forest nursery industry in Europe. The experience of this association can be used to strengthen the State and private sector of nurseries in the Republic of Moldova.

[27] Rusanen, M., Beuker, E., Yrjänä, L., Haapanen, M., & Paanukoski, S. (2021). Finland's forest genetic resources, use and conservation.

[28] Polish State of Forests 2020 report, available at https://www.lasy.gov.pl/pl/informacje/publikacje/informacje-statystyczne-i-raporty/raport-o-stanie-lasow/raport-o-lasach-2020.pdf/@@download/file/raport_o_stanie_lasow_w_Polsce_2020_NET.pdf

[29] Ciccarese, L. (2005). Challenges and successes in regeneration practices in the Northern Mediterranean Basin. Forest Research Information Paper-Ontario Forest Research Institute, (160), 3-10.

[30] European Forestry Nursery Association EFNA - France, http://efna.co.uk/countries/france.html

4. Approaches to reforestation, afforestation and forest landscape restoration in Moldova

4.1. National strategies and plans supporting afforestation and forest landscape restoration

Several national policy documents set the policy support for the expansion of areas covered with forest vegetation through afforestation of degraded land, restoration and extension of protection forest shelterbelts, and rehabilitation of forest ecosystems. A breakdown of such forest-related policy documents is provided in the text below as sub-chapters.

4.1.1. The Strategy for the sustainable development of the forestry sector in the Republic of Moldova (2001)

The Strategy[31] remains the only single valid state strategic document for the sector that has two relevant strategic directions aiming for (1) restoration of the eco-protective functions and bio-production capacity of forest ecosystems, and (2) expansion of areas covered by forest vegetation. *The Strategy has set the target of* ***extending the national forest cover to 15% through afforestation by 2020***, which is equal to establishing circa additional 130 thousand ha of forest vegetation to the current official afforestation cover.

For its implementation, the Government of Moldova (GoM) approved in 2003 the State program for regeneration and afforestation of forest fund lands for the period 2003-2020 (HG No. 737/ 2003) and the general action plan for the implementation of the Strategy for the sustainable development of the national forest sector (HG No. 739/2003). The latest plan expired in 2012.

4.1.2. The Environmental strategy of Moldova 2014-2023

The Governmental Decision No. 301/ 24.04.2014[32] sets as objectives regarding forest resources ***the expansion of forest areas to 15% of the country's territory***, the increase of natural areas protected by the State up to 8% and the ensuring of efficient and sustainable management of natural ecosystems. Expanding forest areas from 11.1% to 15% is to be achieved by planting 15 thousand ha of forest and forest plantations on degraded lands, and promoting a higher proportion of native species in the woods of NFF and outside of it. At the same time, about 30 thousand ha of riparian and water basin protection strips are foreseen to be planted.

4.1.3. Moldova's climate change adaptation strategy

The Governmental Decision No. 1009[33] as of 10.12.2014 planned the afforestation (NFF, shelterbelts, degraded lands), ***reaching the afforestation degree of 15%*** (about 130 thousand ha). Among the objectives of this strategy are:

- Planting of forest energy crops of fast-growing species managed at short production cycles (3-10 years) on communal and private lands;
- Selection of genotypes of forest trees/shrubs adapted to the new climatic conditions;
- Extension of areas of forest protection shelterbelts up to 4% from the area of croplands (additional 50 thousand ha, at least).

[31] https://www.legis.md/cautare/getResults?doc_id=63247&lang=ro
[32] https://www.unep.org/resources/report/environmental-strategy-years-2014-2023
33 https://www.legis.md/cautare/getResults?doc_id=49220&lang=ro

4.1.4. The National Plan for extension of forest coverage for 2014-2018 (No. 101 from 10.02.2014)

The National Plan[34] was set for 2015-18 and envisaged the afforestation of 13 thousand ha, of which 10,300 ha are restoration of degraded lands and 2,700 ha of new riparian buffers and forest belts.

The areas identified for action in the national plan were mostly owned by LPAs and have been selected based on proposals from local communities reflecting their willingness to allocate degraded lands for landscape restoration. There are no precise data on the implementation of the plan; according to independent data sources, about 2 500 ha were afforested under this plan[35].

4.1.5. The Land improvement program for the sustainable management of soil resources for 2021-2025

The program was approved by Governmental Order No 864 from 09-12-2020[36] and sets two objectives related to afforestation plans:

- the specific objective 2.1. targets the combating of surface erosion on 162 ha of agricultural land by 2023 by afforestation of lands subject to landslides;
- the specific objective 2.3. targets the combating of wind erosion (deflation) on 170 ha of agricultural land by 2023 by setting up/rehabilitating 90 ha of protective forest belts, 30 ha of agroforestry protective systems, 30 ha of riparian forest belts and 20 ha of forest belts for the protection of ravens.

4.1.6. The National Development Strategy "Moldova 2030"

The National Development Strategy "Moldova 2030" [37] is currently under approval in the Parliament and it assumes targets for the afforestation of degraded lands, forest restoration and the creation of interconnection corridors between forest bodies and new plantations on communal forests, including those for energy purposes. Among the policies for the implementation of the afforestation plans, the strategy calls for the reduction of administrative burdens and the creation of subsidy mechanisms for the establishment of forest plantations on private lands and the involvement of the population, civil society and the private environment in the expansion of forest areas and their adequate management.

4.1.7. The National Afforestation and Reforestation Programme (NARP) for the period of 2023 – 2032

At the end of 2021, the NARP was formally announced by the Presidency of the Republic of Moldova and its concept was presented to the public. The MoE, through Moldsilva Agency, is currently developing a complete NARP documentation that identifies the scope of the program and its objectives as well as areas subject to afforestation and forest restoration, and stakeholders to be involved in the process. The NARP documentation includes the financial instruments and a monitoring system for the implementation of the program. The World Bank provides technical support to this process, through the EU4Environment regional programme. The MoE conducts discussions with the WB on further assistance on NARP components. At least 100 thousand ha[38] are assumed by the GoM to be afforested/reforested and rehabilitated during the next 10 years mainly by involving LPAs willing to expand their forestlands and the private owners who

[34] https://www.legis.md/cautare/getResults?doc_id=19258&lang=ro

[35] https://www.uncclearn.org/resources/library/nama-on-afforestation-of-degraded-land-riverside-areas-and-protection-belts-in-the-republic-of-moldova/

[36] https://www.legis.md/cautare/getResults?doc_id=125027&lang=ro

[37] https://particip.gov.md/ro/strategy_category/asigurarea-dreptului-fundamental-la-un-mediu-ambiant-sanatos-si-sigur/31

[38] Governmental action plan 2021-2022, National Plan for the expansion of forest vegetation 2022-2030, https://particip.gov.md/ro/download_attachment/14911

intend to establish new forest plantations. The special focus of NARP is the afforestation of degraded lands and ecosystem restoration. In the current planning, the afforestation of 76 thousand ha of new land is expected, including 66 thousand ha of newly created forest plantations and 10 thousand ha of shelterbelts (both riparian and for agricultural land protection)[39]. Additional 24 thousand ha will be the rehabilitated forestlands requiring various interventions (from heavy reconstruction to reforestation). According to the ownership of the land, 61% of the afforestation measures are foreseen on communal lands (LPAs), 27% on private lands and 12% on state lands. Besides its contribution to meet carbon emission targets and securing the climatic-hydrologic regime, the NARP will ensure long-term socio-economic benefits for the population of the country.

4.2. Overview of afforestation plans and projects designed by international organizations

4.2.1. World Bank (WB) Moldova Forestry Note (2014)[40]

The report provides an overview of the forest sector in the Republic of Moldova and strategic advice to help define sector goals and identifies opportunities for consideration in the continued development of the forest sector. The report pointed to the following benefits of afforestation projects:

- increasing the forest area will provide additional benefits in terms of climate change mitigation and as a source of local employment;
- fast growing forest energy crops will offer the potential to relieve the pressure on forests from illegal felling while contributing to national targets for GHG reductions;
- extending the forest belt network will also greatly assist in the fight against soil degradation and erosion.

Several recommendations for actions can be derived from the WB Forestry Note with an impact on the implementation of afforestation plans:

- Building and maintaining stable diversified forests adapted to climate change presents a significant challenge and will require ongoing measures, including research on species selection, adaptive provenances and genotypes.
- A series of regionally based afforestation projects could be a first step to address land degradation. At the same time, the projects will help to create job opportunities, improve agricultural production, contribute towards climate change mitigation and adaptation and to eventually reduce illegal wood production.
- Engaging collaboration with the private sector should lead to the establishment of rural-based small-medium enterprises providing services in areas such as harvesting, afforestation and other forest activities (e.g. Non-timber forest products (NTFPs)).
- A national wood energy program with a target afforestation area using short rotation, high-yielding forest energy crops (suited to the projected climate change impacts) could substantially increase the supply of legally-sourced fuelwood.
- Scientific Research and Technology Transfer are needed for the afforestation of degraded lands, biological disease control agents and the most appropriate species and cultivation methods for fast-growing energy crops.

[39] Agency Moldsilva, Concept note for the National afforestation plan of Republic of Moldova 2022-2031, May 2021
[40] https://openknowledge.worldbank.org/handle/10986/21276

Most of the policy recommendations presented in the WB Forestry Note have been streamlined in the last decade on the forest policy agenda of the Republic of Moldova but have not yet resulted in feasible policy instruments supporting a national-scale afforestation program. The National Development Strategy "Moldova 2030" sets clearer objectives linked to the WB recommendations: e.g. afforestation of degraded lands, forest restoration and ecological corridors, new plantations for energy purposes and private sector involvement in afforestation programs.

4.2.2. World Bank Moldova Climate Adaptation Project (2017)[41]

The project aimed to enhance the adoption of climate-smart practices in agriculture, forestry and pasture management in targeted landscapes while strengthening national disaster management systems. The project had four components, with the second component on climate-resilient forest and pasture management.

The Sub-component 2.1. Community Forest and Pasture Management supports integrated participatory forest and pasture management planning at the community level (LPAs), as well as investments in afforestation and rehabilitation of community lands and pastures in six priority districts. The project was set to finance LPAs-level landscape mapping (i.e. land use "master plans") and 10-year management plans for approximately 29 thousand ha of forest land and pastures that aim a more efficient and sustainable use of these resources. Eligibility criteria for participating LPAs included, among others: willingness to participate, capacity and opportunity for collaboration with neighbouring LPAs, and availability of suitable land.

Investments in selected Local Public Authorities (LPAs) aimed at restoring approximately 1 000 ha of degraded pastures and 1 600 ha of other degraded communal lands, as well as establishing and restoring 1 630 ha of agricultural or riparian shelterbelts. The planning process was credited jointly to the Forest Research and Management Institute (FRMI) and the Local Public Authorities (LPAs) while the technical field work was set to be contracted to the State Forest Enterprises (SFEs) of Moldsilva Agency and the private sector on a competitive basis.

The sub-component 2.2. Ecological Restoration of Degraded Forests included the establishment of a **National Centre for Forest Genetics and Seeds** within FRMI to improve production capacity (both quantity and quality) of certified FRM. For this purpose, native climate resilient species are used in landscape restoration both under Component 2.1 and elsewhere in the country. This was meant to increase the supply of climate-resilient reproductive material and replace the currently dominant introduced species. The National Centre was set to be responsible for seed base management, FRM certification, seed processing and conditioning, the production of containerized seedlings in nurseries, genetic research and in vitro multiplication. The project aimed to specifically invest in containerized seedling production (annual capacity of approximately 1 million seedlings), equipment for seed processing, nurseries and seed quality laboratories, as well as related civil works.

Capacity building and training activities for the benefit of FRMI and Moldsilva Agency staff were foreseen with a focus on nurseries, FRM and climate-resilient ecological restoration, as well as hands-on practice through field trials and demonstration sites.

While the project was not implemented for a lack of policy support to provide financial support for its implementation, it provides an important source of information, which can still be used to identify the strategic options for afforestation programs and the development of FRM.

[41] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/617551497232845961/moldova-climate-adaptation-project

4.2.3. Forestry National Appropriate Mitigation Action (NAMA) – UNDP (2016)[42]

The NAMA project's main objective was to contribute to the process of stopping the degradation of the soil and increasing the carbon capture by approx. 140 thousand tCO_2 per year through (i) afforestation of 45 thousand ha of degraded land, (ii) planting 15 thousand ha of riparian forest belts and (iii) planting 1 500 ha of forest belts for agricultural land.

The implementation of the project involved three phases: the demonstration phase (2016-2018), the scale-up phase (2019-2023) and the transformation phase (2024-2030). The main funding sources for NAMA implementation was expected to be national public funds and international grants. The preliminary cost estimate for implementing the NAMA is € 116.7 million. Of this amount, 26% of the funds were expected to come from national and 74% from international sources. To date, the project is still in the initial phase and its implementation depends on policy support for identifying financial sources and institutional support for the proposed measures.

4.3. Overview of implemented afforestation projects with international support

Several partners are active in land restoration, climate change adaptation and disaster risk management in the Republic of Moldova including the EU, European Bank for Reconstruction and Development, European Investment Bank, Austrian Development Cooperation, Swiss Development Agency, UNDP, United States Agency for International Development, International Fund for Agricultural Development.

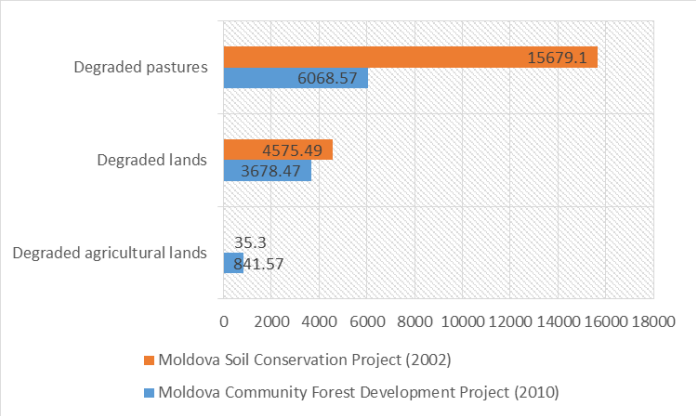
In general, in the Republic of Moldova, there is good expertise in the afforestation of degraded land and degraded agricultural land (figure 6). There are at least two successful carbon sequestration projects, implemented as part of the Clean Development Mechanism under the Kyoto Protocol, which demonstrate the capacity of Moldsilva Agency and FRMI to implement large-scale afforestation of these areas:

- **Moldova soil conservation projects (2002**) implemented by WB/Moldsilva Agency/FRMI between 2002 and 2009 resulted in the creation of new, communal and State forests on 20.3 thousand ha by afforesting eroded and unproductive lands and the stabilization of landslides and improvement of the hydrological regime (Project monitoring report, 2012[43]);
- **Moldova Community Forest Development Project (2010)** implemented by WB/Moldsilva Agency/FRMI between 2006-2011 resulted in the creation of new communal forests on 8.5 thousand ha by afforesting eroded and unproductive lands (Project monitoring report, 2013[44]).

Thus, between 2008 and 2013, Moldsilva Agency afforested about 60 thousand ha of land, of which 20.4 thousand ha were outside the NFF. The categories of land included in the afforestation were mainly owned by the LPAs. Nevertheless, the afforested lands owned by the LPAs have not been monitored and the identification of their status is needed in order to plan the maintenance or restoration works, that will maintain these plantations as forestlands.

[42] https://www.uncclearn.org/resources/library/nama-on-afforestation-of-degraded-land-riverside-areas-and-protection-belts-in-the-republic-of-moldova/
[43] https://cdm.unfccc.int/Projects/DB/SGS-UKL1216031019.22/view
[44] https://cdm.unfccc.int/Projects/DB/TUEV-SUED1352989843.61

Figure 6: Implementation of afforestation projects with international support (ha)



Source: WB Forestry Note

Based on Japanese funds, the project **"Community Support Program for Sustainable and Integrated Forest Management and Carbon Capture Management through Afforestation"**, was implemented between 2010–2014 and contributed to the planting of 1 453 ha, including 1 162 ha forests and 291 ha of other planting activities (restoration activities/completing the regeneration of the stands previously destroyed by illegal logging).

Several small-scale afforestation projects have been implemented with the involvement of NGOs. For example, WWF and Naturton implemented between 2011 and 2021 reforestation and afforestation projects on 50 ha using native species to restore close-to-nature forest ecosystems.

5. Analysis of the current situation of the sector of forest reproductive material

5.1. Legal requirements regarding FRM production in the Republic of Moldova

The forest-related legal framework in the Republic of Moldova is facing changes leaning towards European standards, a new Forest Code and other regulations being under parliamentary procedure. First steps to consolidate a robust system of production have been taken and the use of FRM has already been initiated. Changes to the legal requirements to produce FRM have been approved the Parliament in March 2022 under the **Law regarding the production, marketing and use of forest reproductive material**[45]

The law provides a system of control for seed, cuttings and planting stock that is used for forestry purposes in the Republic of Moldova. The law has transposed the following EC Directives and regulations:

- the Council Directive 1999/105 / EC of 22 December 1999 on the marketing of FRM, published in the Official Journal of the European Union L 11 of 15 January 2000, being partially transposed: art. 5 concerning genetically modified organisms within the meaning of art. 2 points (1) and (2) of Directive 90/220 / EEC and art. 22 on the relevant phytosanitary conditions laid down in Directive 77/93 / EEC;
- the Regulation (EC) no. Commission Regulation (EC) No 1597/2002 of 6 September 2002 laying down detailed rules for the application of Council Directive 1999/105 / EC as regards the model of national basic material lists for FRM;
- Regulation (EC) no. Commission Regulation (EC) No 2301/2002 of 20 December 2002 laying down detailed rules for the application of Council Directive 1999/105 / EC as regards the definition of the term 'small quantities of seeds';
- art. 2, 4 and Annex II to Council Decision 2008/971 / EC of 16 December 2008 on the equivalence of FRM produced in third countries;
- point 1 of Commission Recommendation 2012/90 / EU of 14 February 2012 on guidelines for the presentation of information for the identification of consignments of FRM and the information to be indicated on the label or supplier's document.

The main provisions included in the law refer to:

Forest material production reproduction and the procedure of registration of producers: the law defines new requirements for FRM producers. Private producers are accepted if they follow the provisions of the law. A national register for the FRM producers is to be implemented by the authority in digital format. Moldsilva Agency is the designated authority to register FRM producers and issue registration certificates.

Requirements for the basic materials lists for the FRMs: the regions of origin for the basic materials are to be redefined by the authority as well as the National catalogue of the basic materials for the FRM production. At the national level, the catalogue keeps track of all source units, by categories, species and regions of origin of the FRM. Furthermore, the national catalogue must comply with the provisions of the Protocol of the Association of the Republic of Moldova to the European Forest Genetic Resources Program - EUFORGEN and the Nagoya Protocol.

Certification and identification of the FRM: the authority shall issue an identity certificate of origin indicating the unique registration reference for any FRM derived from the approved base material.

[45] https://www.parlament.md/ProcesulLegislativ/Proiectedeactelegislative/tabid/61/LegislativId/5280/language/ro-RO/Default.aspx

Use of material forest reproduction: the conditions for using FRM are set, and priority will be given to that of local origin, adapted to climate change requirements. Moldsilva Agency is the designated authority to authenticate both the identity and quality of FRM, as well as the correctness of their use in practice.

Marketing, import and export of the forest reproductive material: the conditions for labelling and selling of FRM are set. The import of FRM is allowed from exporting countries, which implement the same requirements regarding the approval of basic material and the production of FRM as the Republic of Moldova.

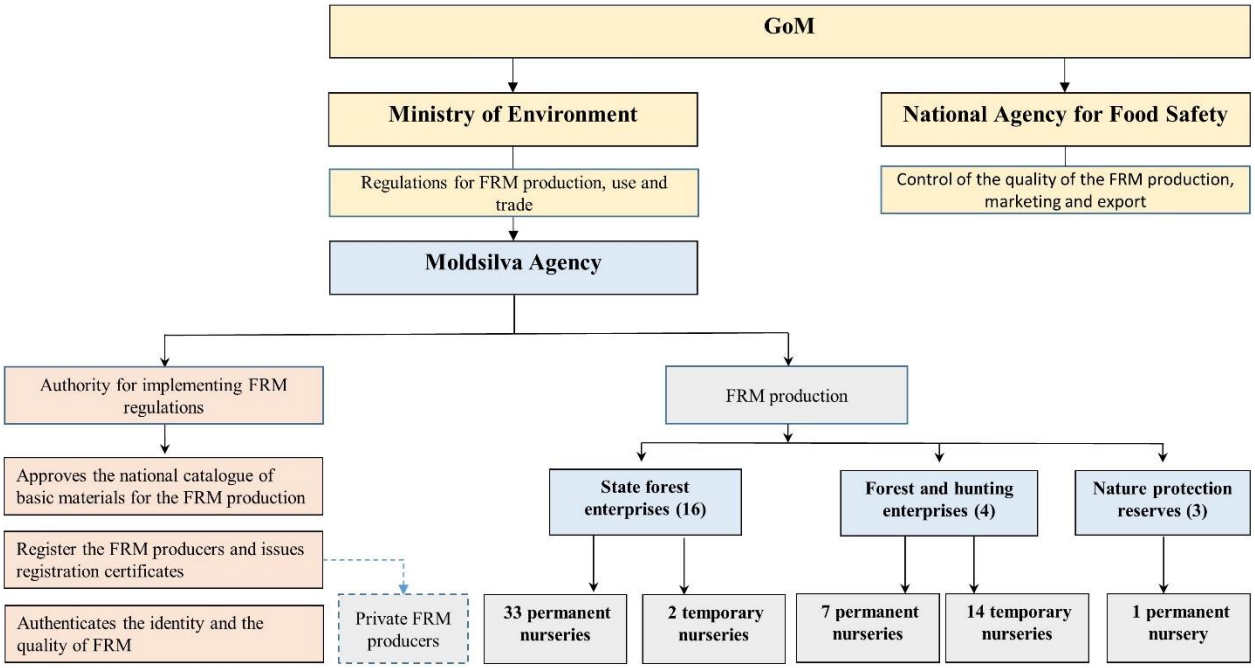
Verification of production, marketing, import and export of materials forest reproduction: the authority is responsible for verifying the identity of the FRM, documented by issuing an identity certificate.

By adopting this law, the Republic of Moldova has adapted to the general legal framework applicable in the EU for FRM production. This integration is specifically mentioned in the text of the law which states that the measures provided for this law do not apply to FRM that is intended for re-export to EU member States and exporting countries that show the same requirement regarding the approval of the basic material and the production of FRM as the Republic of Moldova.

5.2. Organization of the FRM sector in the Republic of Moldova

The Law regarding the production, marketing and use of forest reproductive material sets the institutional framework applicable for FRM production in the Republic of Moldova (figure 7). The public authorities in charge of the FRM regulatory framework are: (i) the MoE elaborates, promotes State policy and approves the regulations in the field of production, marketing and use of FRM; and (ii) the National Agency for Food Safety controls the quality of the FRM at all production stages, including inspections in the field and forest nurseries and issues phytosanitary certificates for the FRM production and marketing activities.

Figure 7: The institutional framework of FRM production in the Republic of Moldova (2022)



Moldsilva Agency is the designated authority under the MoE to implement the provisions of the FRM legal framework specifically for:

- The National catalogue of basic materials for the FRM production: Moldsilva Agency approves the requirements regarding the establishment and description of the regions of origin of the basic materials and delineates them on topographic maps;
- The State Register of FRM producers: Moldsilva Agency register the FRM producers and issue registration certificates in this regard;
- the Database of the annual reports presented by the FRM producers: Moldsilva Agency has to supervise the production process and the FRM quality and to authenticate both the identity and quality of the FRM, as well as the correctness of their use in culture.

In the Republic of Moldova, the delimitation of the regions of provenance based on geographical criteria has already been started by the FRMI between 2014-2020[46]. The same methodology implemented in Romania was used to apply geographical criteria (latitude, altitude and orography of the land). Based on the carried-out research, three regions were designated: the Northern Moldova Region, the Central Region and the Southern Moldova Region. There is no vast territory, and there were no significantly different ecological conditions identified to justify more regions. The regions' boundaries conveniently overlapped the ones of administrative regions and forestry entities. This design will allow regional boundaries to be precisely identified to facilitate the transfer of FRM and correctly identifying the sources.

The production of FRM in the Republic of Moldova is largely based on the network of tree nurseries belonging to Moldsilva Agency (figure 8). Moldsilva Agency produces the reproductive material for its use in reforestation and afforestation as well as selling to third parties according to prices established by Moldsilva. Its nurseries deal mainly with deciduous species (including native and introduced/naturalized ones), while coniferous production is limited to appropriate nurseries located at higher elevations (e.g. for Christmas trees or landscape designing).

The regional local forestry entities of the Moldsilva Agency usually organize the nursery production to ensure the necessary amount of seedlings for planting purposes in the coming years. This quantity is based on the required annual average of seedlings and annual sowing area in nurseries in each forest district. The annual planning is usually done in September each year. The plan indicates areas for cultivation with different species and the quantities of seeds and vegetative seedlings, depending on the sowing or regeneration scheme adopted.

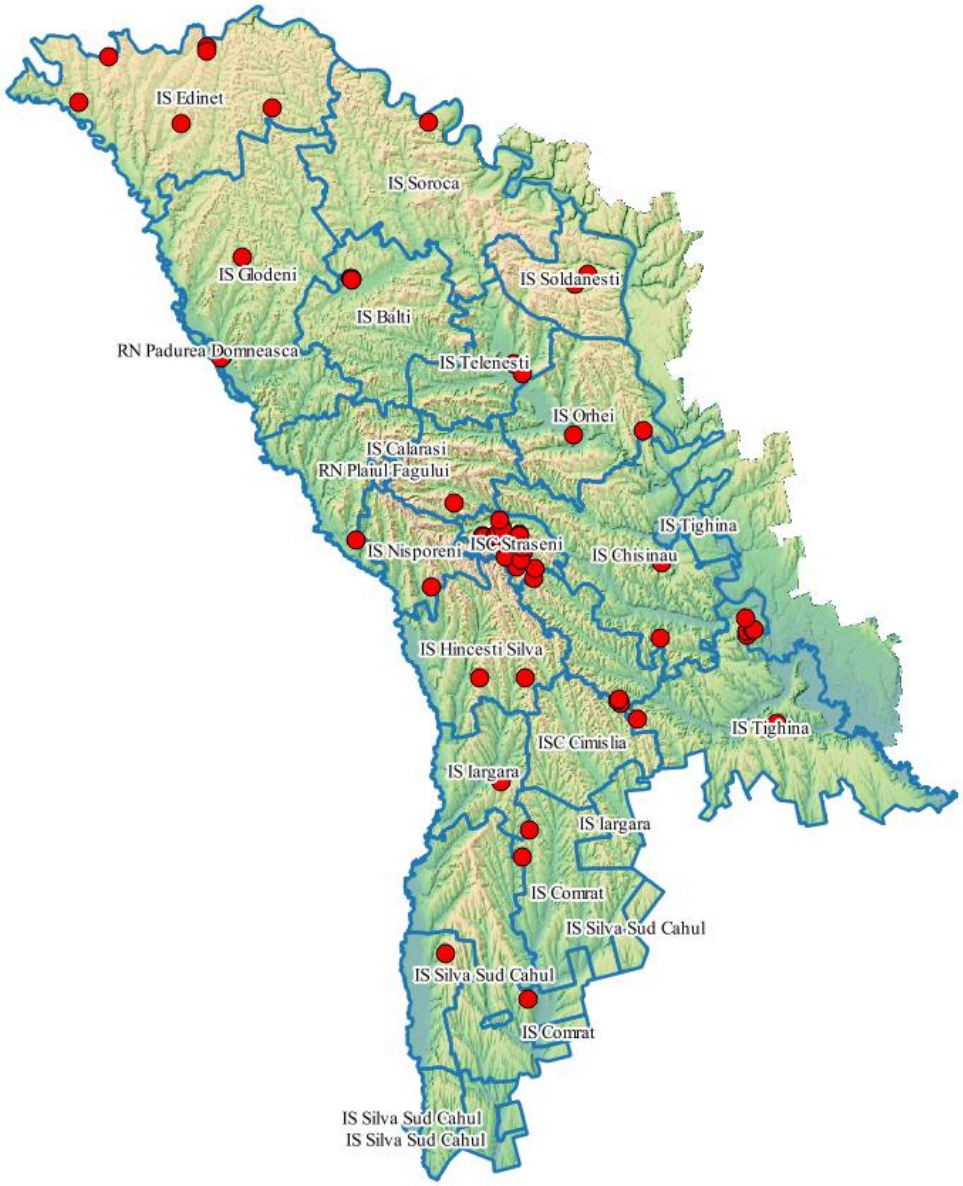
Some private nurseries outside Moldsilva Agency produce species/taxa used in either agriculture (horticulture, households, private orchards etc.) or landscape design, including various forest-related planting materials demanded by the markets. However, none of these private nurseries is registered to produce FRM according to the legal requirements.

The coordination of FRM production with the National Afforestation and Reforestation Programme for the period of 2023 – 2032 (NARP) is essential in the current organizational structure, considering the centralized planning system of the network of nurseries. In the absence of competition, market mechanisms are less considered in planning FRM production, in the current organizational structure. Moreover, Moldsilva Agency has been assigned a double role. On the one hand, the Agency is the main FRM producer in the country and on the other hand, it has been legally assigned with supervision and control authority over all FRM producers. Experiences from other countries e.g. Romania show that a clearer separation of

[46] Florentă, G., Caisîn, V., Florenţă, V., & Miron, A. (2021). Limitele regiunilor de proveniență pentru materialele de bază din care se obțin materiale forestiere de reproducere din Republica Moldova. In Conservarea diversităţii biologice–o șansă pentru remedierea ecosistemelor (pp. 106-111).

management and controlling function for FRM production allows private producers to get an important share of the market.

Figure 8: The network of nurseries for forest reproductive materials of Moldsilva Agency



Source: FRMI

5.3. Current capacities and production

The assessment of the capacities and production of reproductive materials is done based on two data sources:

1. **The report "Study on the production of forest reproductive material in forest nurseries in Moldsilva Agency" was elaborated by FRMI in 2017** (Florenta G., Florenta V., 2018). The study was conducted through data collection of entities belonging to Moldsilva Agency. According to a data collection protocol including information from 2017 regarding general data about the nurseries, the staff involved in the nurseries' activities, the organization of the production capacities and the technological capacities. Data were centralized by the researchers from FRMI.
2. **An update of the previous study was conducted by FRMI in 2022** for the assessment of the current state of forest nurseries and the identification of forest nurseries for the establishment of centres for

the industrial production of forest saplings. The data collection for the study started in February 2022 and was based on reports from the territorial SFEs of the Moldsilva Agency. The study is still in draft form.

5.2.1. Number of nurseries and their organization

As of 2022, within Moldsilva Agency 57 nurseries cover a total area of 962.3 ha (Table 2). Compared with the situation identified in 2017, the total area of the nurseries has decreased by 25.35 ha, mainly because one permanent nursery from SFE Orhei (23.2 ha) is currently not in use.

Table 2. Forest nurseries from entities subordinated to Moldsilva Agency

State forest enterprise	2017		2022	
	Area (ha)	Number of nurseries	Area (ha)	Number of nurseries
SFE Bălți	28.54	3	28.54	3
SFE Călărași	23.2	1	23.2	1
SFE Chișinău	154.6	2	154.6	2
SFE Comrat	35.75	2	35.75	2
SFE Edineț	52	6	52	6
SFE Glodeni	50	2	50	2
SFE Hâncești - Silva	68	2	68	2
SFE Iargara	65.2	1	65.2	1
SFE Nisporeni-Silva	40.8	1	40.8	1
SFE Orhei	46.4	2	23.2	1
SFE Silva-Centru Ungheni	41.9	1	41.9	1
SFE Silva-Sud Cahul	96.6	1	96.6	1
SFE Soroca	32.9	1	32.9	1
SFE Șoldănești	28.9	2	28.9	2
SFE Telenești	89.9	2	89.9	2
SFE Tighina	38.4	7	38.4	7
FHE Cimișlia	53.4	2	53.4	2
FHE Taraclia (Manta-V)	9.2	1	9.2	1
FHE Sil – Răzeni	9	1	9	1
FHE Strășeni	16.97	20	14,82	17
Nature reserve Pădurea Domnească	6	1	6	1
Total	**987.66**	**61**	**962.31**	**57**

Regarding their use over time, 41 nurseries are categorized as permanent nurseries and 20 are temporary nurseries, as of 2017 (Table 3). Temporary nurseries are small, intended for a limited production of saplings, for a small number of species, and for a short period or until the afforestation of the territory for which they were initially established. Among the permanent ones, 19 are categorized as big nurseries (above 20 ha) totalling an area of 792 ha (80% of the total areas of the nursery network). Since 2017, most of the existing nurseries (51 out of 61) have not had the technical documentation legally required for the organization of their activities.

Table 3. Classification of forest nurseries by area category and duration of operation (2017)

Duration of operations	Size category					
	Small (<5 ha)		Medium (5 – 20 ha)		Big (>20 ha)	
	#	ha	#	ha	#	ha
Permanent	9	11.15	14	158.59	19	792.85
Temporary	18	14.77	1	10.3		
Total	27	25.92	15	168.89	19	792.85
%	44	3	25	17	31	80

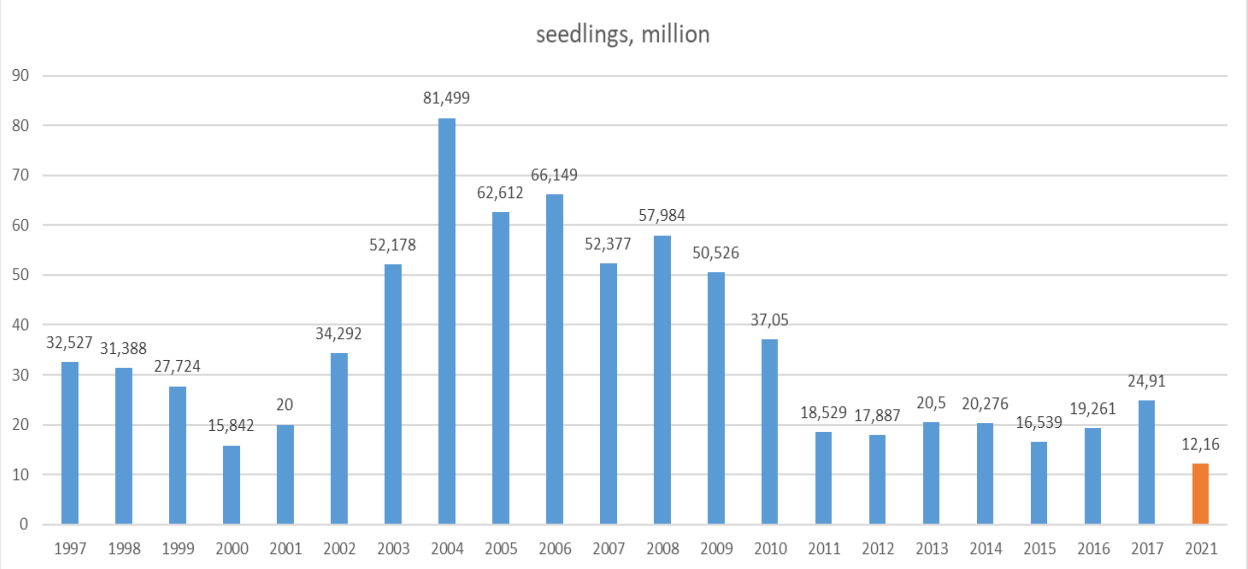
5.2.2. Total production capacity

According to the situation in 2017, for the organization of the land in nurseries, the area designated to produce seedlings for afforestation represents a total of 630 ha (64%). The area occupied by other crops is 288.22 ha (29%) with the remaining area being used for administrative purposes (7%).

Considering the land organization in the existing nurseries, their estimated total production capacity is 60 million seedlings. Nevertheless, the maximum production capacity during the last three decades was 81 million seedlings reached in 2004 (figure 9).

There are important variations in the yearly production of the nurseries, which can be linked with the implementation of afforestation plans: between 2003-2009 the production capacity was constantly above 50 million seedlings. However, since 2011, the production capacity decreased to 18-20 million seedlings. Comparing the area of nurseries available to produce seedlings (630.46 ha) and that actually used for that purpose in 2017 (244.43 ha) it is found that 38.8% of the capacity is used, corresponding to 20 million seedlings.

Figure 9. Evolution of seedlings production in the nursery network of the Moldsilva Agency



The updated study on the production capacity from 2022, shows a significant decrease in the production capacity of the nurseries belonging to Moldsilva Agency. According to the data collected from the territorial SFEs, in 2021 only 45.3 ha were used in the production of seedlings and thus the production capacity reached a minimum of 12.16 million seedlings (table 4). Therefore, the current production capacity of the existing nurseries is used only to a small extent.

Table 4. Production of FRM in nurseries in 2021 compared to the average for the years 2002 - 2020

Production year	Total area with seedlings (ha)	Total seedlings production	Seedling production /1 ha
2021	45.31	12,160,610	268,000
Average production 2002-2020	144.68	33,050,000	228,000

Regarding the distribution of the production capacity in the three regions of the Republic of Moldova (table 5), almost half of the seedlings are produced in the nurseries in the South Region, while the contribution of the North region was less than 20% in 2017.

Table 5. Regional repartition of the seedlings' production capacity (2017)

Region	Total seedlings produced	
	#	%
North	4,378,851	17.57
Centre	8,576,395	34.42
South	11,962,893	48.01
Total	24,918,139	100.00

5.2.3. Production capacities by species

The total number of species used in the production of seedlings was 128 in 2017 but decreased to 43, according to the latest records from 2022. In 2017, the black and honey locust accounted for half of the total number of seedlings produced (table 6), being the most used species in current afforestation and reforestation plans. The share of these species remained the same in 2021 as well as in the plans for 2022.

Table 6. Seedling production by species (2017)

Species	Total	
	#	%
Coniferous	331 165	1.33
Oak species	2 555 263	10.25
Black locust	11 539 438	46.31
Honey locust	1 095 300	4.4
Juglans	1 212 498	4.87
Maple	1 689 000	6.77
Linden	228 064	0.92
Prunus	222 074	0.89
Willow	43 378	0.17
Poplar	68 616	0.28
Shrubs	2 289 930	9.19
Secondary species	3 643 213	14.62
Rosa species	200	
Total	**24 918 139**	**100**

Oak species represented only 10% of the total number of produced seedlings, thus posing a question about the capacity to implement restoration projects of oak-based forest ecosystems.

Adopting new technologies for the FRM production (harvesting and processing of fruits, seeds and cones, conditioning and preservation of seeds, preparation of seeds for sowing and, last but not least, the culture of the species in the nursery) is mainly influenced by the type of species envisaged in the afforestation projects. Now, those species with good results in their establishment and without much investment are cultivated in nurseries on a large scale. This applies for example to locust compared to downy oak, linden species, etc.

5.2.4. Production capacities by the size of seedlings

Managing seedling production in nurseries involves various care operations for plants of different ages and dimensions. As for 2017, the one-year seedlings represented 54% of the total production capacity, while the better-fit tall saplings more prone to increase the success rate of afforestation projects represented only 4% (table 7). Thus, the planning process of the afforestation projects needs to acknowledge that producing good quality seedlings requires the maintenance of seedlings in the nurseries for at least two years.

Table 7. Seedling production by their size (2017)

Type	#	%
One-year seedlings	13,478,720	54.09
Two-year seedlings	10,464,717	42.00
tall saplings	974,702	3.91
Total	24,918,139	100

According to the technical assessment, 82% of seedlings correspond to the standards in force but in some nurseries, the percentage can be as low as 15%. This material used in afforestation activities often leads to negative outcomes. As a result, the volume of maintenance works in plantations increases, which implicitly causes a rise in the afforestation cost per forested hectare.

There is currently no capacity for containerized seedling production of any species, even though different entities have identified the need for the production of containerized seedlings as an essential aspect of implementing afforestation projects.

5.4. Conditions of production in nurseries

Most nurseries are located near populated centres at an average distance of about 3 km, with a maximum distance of 11 km (FE Comrat). In most nurseries (37), the access is possible via ground roads. Access to nurseries in this case is only possible in dry weather, otherwise, all-terrain vehicles are needed. According to the nature of the road, asphalt roads were identified only for seven nurseries and other paved roads for seventeen nurseries.

The mechanization of the production process is obsolete. In 2017, 55 tractors were used in forest nurseries, of which 23 (42%) were on tracks and 32 (58%) were on tires. Over 50% of the total equipment was produced in the 70s and 80s of the previous century. The quality of the planting material produced in the nursery is directly affected by the condition of the tools and types of machinery used. The biggest problem in this area is the lack of seeders, planting machines used for transplanting, and special ploughs for seedling removal.

Another current significant limitation in planting stock production in forest nurseries is the lack of water sources for crop irrigation. Groundwater is located at a depth ranging from two to three meters in the Prut River meadow or at the bottom of the valleys. However, in several cases, this depth descends up to tens of meters or even deeper, making the water resource inaccessible. In 2021, none of the nurseries that produced seedlings was able to use irrigation techniques. As a result, the frequent droughts during the growing season affected the development and growth of FRM. Every year, considerable areas of sowing are lost, and the produced planting material is of low quality, not meeting the current requirements of the standards.

In this context, it becomes crucial to review the nurseries' efficiency and adopt modern technologies to obtain the necessary quantity and quality of planting stock at a lower cost.

5.5. The basic materials list (seed sources)

The basic materials list (seed sources) constituted in the State's property, is approved separately by the order of the Moldsilva Agency on forest entities. According to the last order to update, the seed base (Moldsilva Agency order no. 350 of 22.12.2017 "On the re-examination, approval and updating of the seed base sectors") the total area of stands designed for seed production was 3 924.4 ha (table 7). Starting in 2017, all the seed sources for forestry entities have been revised, and as a result, their area increased to 4 649.85 ha.

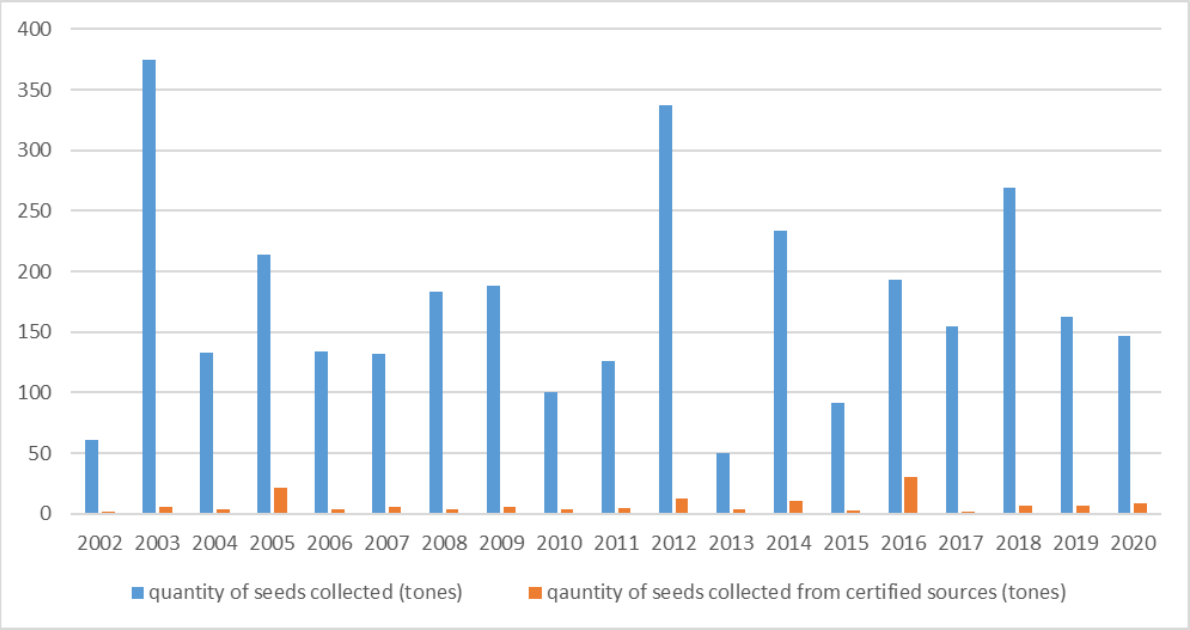
Currently, 90% of the area is used for producing oak seeds (e.g. 56% - sessile oak, 26%- pedunculated oak), while for black locust the certified seed sources cover only 2.6% of the total.

Table 8. The seed sources types (2017)

Type of seed sources	Number	Area covered (ha)
Stands designed as seed sources	221	3105.04
Seed orchards (clones, families)	11	85
Ecological seedlings units	1	3.9
Geographical seedlings units	2	16.6
Genetic reserves	7	713.5

Only a small share of the collected seeds originates from the seed source base (figure 10). According to the data presented on the web page of the Moldsilva Agency, for the period 2002-2020, on average only 4.5% of the collected seeds were collected from stands registered in the basic material lists ranging from 15% in 2016 to 1.6% in 2003. These differences may also be linked to the fructification capacity of the existing stands.

Figure 10. Quantity of seeds collected in total and from certified seed sources



Regarding the quality of the seeds used in the production of FRM, the reports from Moldsilva Agency show that in 2002 -2020, germination tests were applied for 62% of the seeds. Concerning their germination capacity, a significant share of seeds (47%) was classified as inferior.

There are no data available regarding the quantities stored in seed warehouses.

6. Assessment of needs and plans on future afforestation and forest landscape restoration

6.1. Needs and objectives on future afforestation and forest landscape restoration

6.1.1. Use of reproductive material for reforestation

Reforestation of existing forest stands is done based on the provisions of the forest management plans, which establish the area and the species composition for the regeneration of the stands on a ten years basis. Thus, an assessment of the needs for reproductive material can be done considering the availability of forest management plans, but yearly variations can be recorded depending on the implementation of the regeneration cuts.

The report conducted by FRMI in 2018[47] has made an overall assessment of the FRM needed for the planned reforestations based on Moldsilva's forest management plans in place at the level of 2017. The planned reforestation area was calculated at 36.8 thousand ha for the entire validity of the forest management plans (10 years) which makes an average reforestation area of 3 700 ha/year in the public forests managed by Moldsilva Agency.

Based on the technical requirements for reforestation, the calculated need for FRM is 182 million seedlings in the decade, or an average of 18.2 million seedlings per year. This quantity represents 91% of the viable seedlings produced in 2017, thus showing that the production capacities of Agency Moldsilva's network of nurseries are mainly used for its reforestation needs.

Considering the species´ compositions required by the current forest management plans, only 36% of the seedlings needed for reforestation are oak species[48], while black locust has a share of 30%. In 2017, the

[47] Florenta G., Florenta V., 2018: Study on the production of forest reproductive material in forest nurseries in Moldsilva Agency

[48] There are four oak species used in FRM production: sessile oak, pedunculated oak and pubescent oak are native while red oak is introduced

production of oak species in nurseries was only 10%, while the production of locust species (with black locust being the main) constituted 50%. This points to the fact that current reforestation activities use to a large extent, species that do not meet the forest restoration objectives.

6.1.2. Objectives for rehabilitation of existing forest ecosystems

The natural composition of existing forests calls for a strategic approach involving the rehabilitation of many existing stands towards healthy forest ecosystems corresponding to existing natural conditions. In the Republic of Moldova, only 33% of the existing ecosystems are identified in the forest management plans as naturally regenerated stands based on native species. 51% are artificial stands and 16% (corresponding to 45 thousand ha) are natural stands with a composition that do not correspond to the natural conditions.

While the focus of existing strategies is the extension of forest areas, restoring existing forest stands by using native species is not strategically addressed. According to the discussions with the representatives of Moldsilva Agency, currently, the Agency does not have a strategic plan to restore existing forest ecosystems towards healthy natural structures, but a strategic approach is foreseen in the future in the context of NARP.

Some efforts for forest restoration were made with support from institutional donors, e.g. the CO2 sequestration project planned by WWF and Terraformation in cooperation with the local community which resulted in the afforestation of 50 ha based on native species and structure/composition as close as possible to the natural forest ecosystems.

6.1.3. Needs for forest reproductive materials for afforestation programs

Different assessments have been done to calculate FRM quantities required considering the proposed national afforestation plans.

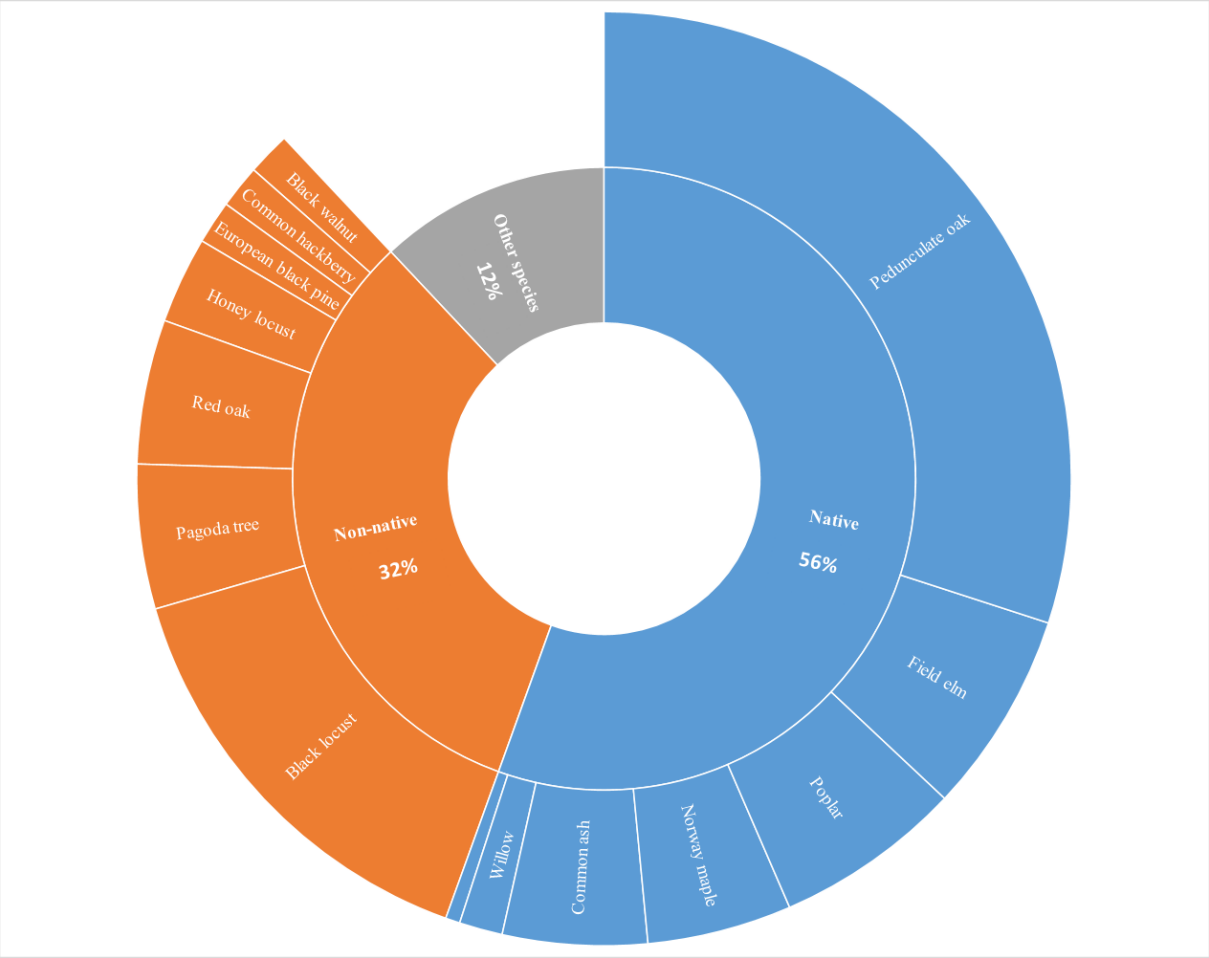
According to the **National Plan for Afforestation 2015-2018,** the afforestation of 13 000 ha was foreseen (10 300 ha of restoration of degraded lands and 2 700 ha of new riparian buffers and forest belts). An annual area of 3 260 ha was envisaged for the extension of forest vegetation corresponding to an annual need of 17.1 million seedlings. The total number of seedlings for the implementation of the program was calculated at 68 million. However, there is no official evaluation of the implementation of this plan, the targets being only partially accomplished.

The **NARP 2023– 2032,** which is under development, targets the afforestation of 100 thousand ha.

For the implementation of the NARP, in April 2021, a concept note was drafted by the Moldsilva Agency and its FRMI for the planning of the afforestation program[49]. According to this concept note, the afforestation of 76 thousand ha is proposed, equivalent to an average annual area of 8 thousand ha. To achieve this objective, the annual production capacity of seedlings is calculated at 48 million. Native species represent 56% of the estimated needs for seedlings. Pedunculated oak is the main native species (30% of the estimated needs for seedlings), with an annual planting area of 2 400 ha. Other planned native species are common ash, field elm, Norway maple, poplar, willow, common walnut. Non-native species represent 35% with black locust having a share of 15% corresponding to 1 200 ha afforested annually (figure 11).

[49] Agency Moldsilva, Concept note for the National afforestation plan of Republic of Moldova 2022-2031, May 2021

Figure 11. The estimated share of species for NARP implementation



The cost for planting 1 ha of forest was evaluated at 2 410 Euro/ha, including identification of the lands, soil preparation, planting of the area and doing maintenance of the plantations for the first five years. Nevertheless, independent expert opinions consider that the real cost can be two times higher, taking into consideration: (i) a better quality of work and of the results, (ii) the increased price of fuel and services, and (3) the sustainability of post-planting works. Thus, according to independent sources, a more realistic cost of the planting and maintenance of the plantations can vary between 3 500 Euro/ha and 5 000 Euro/ha.

6.1.4. Estimation of the overall needs for the production of forest reproductive materials

Combining the estimation of FRM needs for the reforestation of existing forest stands and for the implementation of the current plans for afforestation and forest ecosystems restoration, the overall estimation varies between 66 to 80 million seedlings to be produced annually (table 9).

Table 9. Estimation of the needs for forest reproductive materials considering the current plans for afforestation and forest ecosystems restoration

No	Purpose	Annual needs (million seedlings)
1	Seedlings for the reforestation of existing forest stands	18 -20
2	Seedlings considering current national afforestation plans	48 – 60
3	Seedling for rehabilitation of existing forest ecosystems	No estimation

The existing network of nurseries has been able to cover such levels of production (e.g. between 2004 and 2006), especially in terms of the amount of seedlings but less on the requested species composition. The production of seedlings has drastically dropped in the last decade and the current production conditions are facing significant constraints. Limitations include, e.g. lack of skilled workers, obsolete mechanization, and lack of irrigation and water sources. Consequently, a reconsideration of the existing network of nurseries is needed to increase production capacity and efficiency.

6.2. Current plans for the development of FRM production

6.2.1. Proposed approaches

The need to restructure the current network of nurseries used for FRM production has been acknowledged in different projects.

The recommendations from the World Bank for Climate Adaptation Project (2017)[50] proposed specific measures for FRM production and the establishment of the National Centre for Forest Genetics and Seeds. The centre was set to be responsible for seed base management, regeneration material certification, seed processing and conditioning, the production of containerized seedlings (nursery) and genetic research and in vitro multiplication.

This measure was also integrated into the concept note drafted by Moldsilva Agency for the implementation of the NARP 2023-2032[51]: the establishment of the National Centre for Forest Genetics and Seeds including the production of 15 million seedlings with an estimated cost of 2.6 million Euros. Additionally, the concept proposes the establishment of two additional centres for the industrial production of 15 million forest seedlings with an estimated cost of 4 million Euros.

6.2.2. Evaluation studies for the establishment of industrial production centres

In February 2022, the FRMI started the elaboration of the study for the assessment of the current state of forest nurseries and the identification of forest nurseries for the establishment of centres for the industrial production of forest saplings. The data collection was based on reports from the territorial enterprises of Agency Moldsilva.

The study aims to identify the most suitable nurseries for the establishment of three industrial centres for FRM production, considering the establishment of one centre for the industrial production of forest saplings for each region of the Republic of Moldova, namely the northern, central and southern regions.

[50] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/617551497232845961/moldova-climate-adaptation-project

[51] Agency Moldsilva, Concept note for the National afforestation plan of Republic of Moldova 2022-2031, May 2021

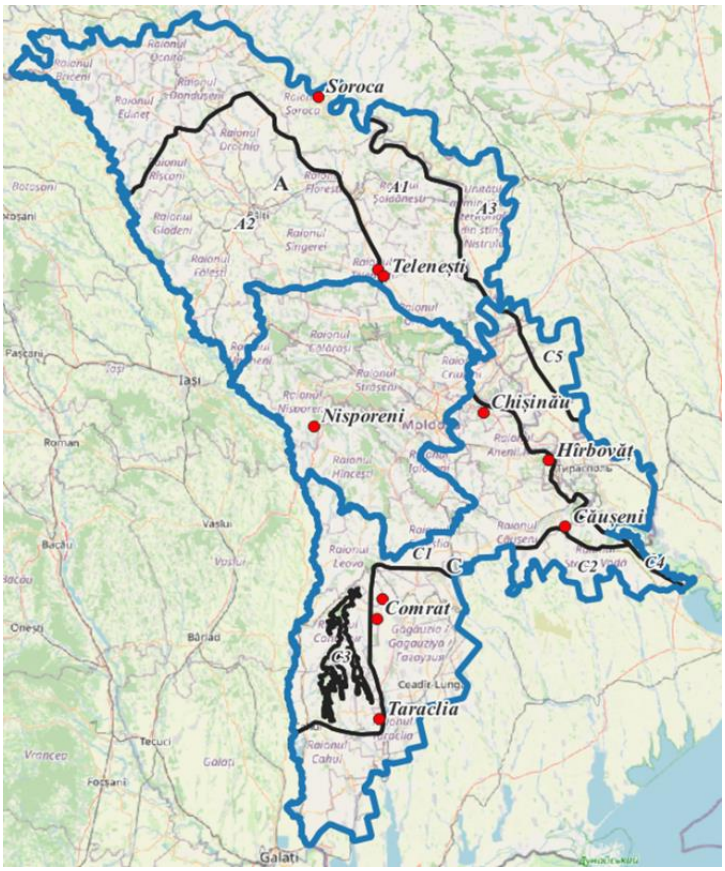


Figure 12. The distribution of the analysed nurseries in the three regions of Moldova

Thus, seven entities subordinated to the Moldsilva Agency were selected for the in-depth analysis according to the three regions: SFE Soroca – for the northern region, SFE Nisporeni-Silva, SFE Telenesti, SFE Chisinau for the central region, and SFE Tighina, SFE Comrat, SFE Taraclia for the southern region (figure 12).

Within the seven selected SFEs, thirteen forestry nurseries cover a total area of 480.5 ha representing 50% of the total size of nurseries belonging to the Moldsilva Agency. For these nurseries, a detailed analysis of the production capacities has been performed based on technical-economic indicators suitable for creating centres for the industrial production of forest saplings.

The following indicators have been analysed:

- **The size of nurseries**: 7 of them are big nurseries (largest than 20 ha), the largest having 143 ha, 4 have a size between 10 and 20 ha while two are smaller than 1 ha.
- **The access road to the nurseries**: 7 nurseries are accessed on ground roads (not asphalted) which are only accessible during dry weather, otherwise, all-terrain vehicles are needed. Asphalted roads which lead to 6 nurseries and paved roads to 2 nurseries. Since access is essential for the transportation of the produced FRM, preference should be given to well-maintained paved or asphalted roads.
- **The distance to the nearest locality** is an important indicator for the capacity to ensure the availability of the necessary labour force especially considering the seasonality of the work in nurseries. Nearby villages are in an average radius of about 15 km. Only in 5 cases, the nurseries are located within a walkable distance (below 2 kilometres). In most cases, the transport of workers is done with the help of a cart (3 cases) or cars (9 cases) belonging to the nurseries. There are cases where the nurseries do not provide means of transport, and the workers must find transport.
- **The source of irrigation water** is an important indicator considering that lack of water is a crucial constraint to the production of FRM. Water sources are usually rivers, ponds and artesian wells. In most of the cases, the reports from the forest units estimate that the existent water sources can ensure the irrigation needs of the nurseries. However, the main problem appears to be the lack of infrastructure and technologies for proper irrigation systems.
- **Access to the electricity network** is not available for 5 forest nurseries and when existing, the network's electrical power is not always suitable for the use of, e.g. irrigation pumps.

- **Updated soil mapping studies** are largely missing, only in 4 cases the studies had been done after 2010. Fertilizer administration is applied only in 1 nursery.
- **Existing infrastructure** (administrative offices, greenhouses, seeds warehouses) also varies largely between the analysed nurseries. Seeds warehouses are reported only in 3 nurseries, seedlings warehouses in 2 nurseries and greenhouses only in 1 nursery. No investment in the infrastructure of the nurseries has been done in the last years, nor is foreseen for 2022.
- **The mechanization status of the nurseries** varies to a large extent between the analysed nurseries, but in general, it is obsolete. Moreover, the machinery and equipment used in nurseries are also used for other forestry work.

Considering these indicators, the draft study of the FRMI proposes the establishment of three centres for industrial production based on the nurseries existing in SFE Tighina, SFE Chisinau and SFE Telenesti. Nevertheless, the concrete objectives of these nurseries, the range of activity, the area required for the installation of the nursery, the production of saplings by year and the technologies to be used, are not yet assessed and defined.

Notably, the plans for implementing the industrial centres for FRM production do not phase out the production of the existing nursery network of the Moldsilva Agency. On the contrary, the industrial centres are foreseen as the main suppliers for the afforestation plans, while the other nurseries need to be improved to produce the necessary seedlings for the reforestation of the stands as set in the forest management plans.

6.3. Identification of synergies and possible conflicts with other sectors in forest landscape restoration

Preserving and expanding the forest areas in the Republic of Moldova has been a permanent objective in the national strategic plans. Different strategic plans recognize the vital role of forests in environmental protection by reducing the harmful effects of climate change, while improving air quality, stabilizing the hydrologic regime, and protecting soils and biodiversity. The National Development Strategy "Moldova 2030"[52], which is currently under approval, states explicitly that expanding forest areas will contribute to **reducing the effects of climate change, preventing erosion and continuous degradation of soils and restoring the appropriate level of groundwater in the soil**. Finally, **forests are an alternative source of energy**, when they are used sustainably and according to rigorous planning of harvesting and regeneration of forested lands.

Different assessments and simulations, such as the World Bank for Climate Adaptation Project[53] predict that Moldova's forests will be seriously affected by a changing climate, which will likely lead to the phenomenon of mass drying in several regions of the country. Agriculture, water resources management and forestry are among the sectors considered most at risk from climate change impacts, as are human health, energy and infrastructure[54]. Restoration of existing ecosystems and afforestation programs are seen as the key elements to increase the protection against natural disasters/extreme phenomena (soil structure improved, better water filtering, wind-breaking).

Combating soil degradation, soil preservation and increasing soil fertility are objectives specifically addressed by the Moldavian land improvement program for the sustainable management of soil resources for the years 2021-2025[55]. It contains afforestation measures like water protection forest belts, the planting of shelterbelts, hedgerows and afforestation of degraded lands. As land degradation occurs on larger scale

[52] https://particip.gov.md/ro/strategy/strategia-nationala-de-dezvoltare-moldova-2030/4

[53] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/617551497232845961/moldova-climate-adaptation-project

[54] https://openknowledge.worldbank.org/handle/10986/21276

[55] https://www.legis.md/cautare/getResults?doc_id=125027&lang=ro

in the Republic of Moldova, the proposed afforestation measures are priority targeting the identification and planting of lands with extreme degradation.

The water management sector will benefit from increasing watershed protection services associated with run-off/erosion control and soil stabilization. In addition, the water management sector considers the positive impacts of forests in water flow regulation and water quality maintenance for water supply facilities. The water supply for irrigation measures is also becoming essential for the agricultural sector in the context of extremely dry seasons.

The agricultural sector in the Republic of Moldova has been strongly relying on the practice of forest protection shelterbelts, which contribute to increased productivity, the protection of fields from wind and water erosion, and the regulation of microclimates by providing shade and by providing habitats/refugees for biodiversity. Nevertheless, in recent years, many protection shelterbelts have been affected by illegal logging to ensure the high demand for firewood in local communities. Thus, besides re-establishing forest protection belts for agricultural systems and riversides, alternative sources of firewood provisions are needed to ensure the preservation of the protection shelterbelts.

Energy security is becoming a major objective in the current socioeconomic context. Poverty affects primarily the rural population and remains an important issue in Moldova. Thus, many rural households depend on forests for subsistence as a source of fuel for cooking and heating. This social need is only partially satisfied by existing forest resources. Furthermore, firewood provision constitutes a major threat to the forests and protection shelterbelts, including the newly afforested lands. A possible solution is to ensure a sustainable wood supply by afforestation with short-rotating, high-yielding forestry energy crops (e.g. Forestry NAMA, 2016[56]).

Nature-based tourism has gained importance especially by establishing recreational facilities in the existing forests. Efforts are needed to strategically include the presence of urban and peri-urban forests in the current afforestation policies to reduce the pressure on existing ecosystems, especially in areas where restoration measures are foreseen.

Enhancement of biodiversity protection and provision of biological corridors in fragmented landscapes are identified as benefits of afforestation programs in line with ongoing landscape planning approaches. On the one hand, the restoration of existing ecosystems according to the natural type of forests will ensure the stability of forest ecosystems and contribute to climate change adaptation and mitigation. On the other hand, considering the fragmentation of forest resources and their uneven distribution across the Republic of Moldova, the afforestation plans need to consider the enlargement of the forest complexes, and the creation of interconnection corridors between forest bodies, especially in areas with low coverage of forests.

The main conflict related to the implementation of afforestation programs is linked to the change of land use for the available land for afforestation. The draft study of the FRMI for the planning of the national afforestation program[57], has identified a potential of more than 200 thousand ha of degraded land to be used for afforestation programs. 123 thousand ha of the 200 thousand ha are heavily eroded lands while the remaining 77 thousand ha are related to landslides and water ravines. Notably, the area of degraded land is larger than the necessary land for the implementation of the national plan for afforestation. However, the successful implementation of the program relies on convincing the current owners of the potential benefits of the land use change by afforestation measures.

[56] https://www.uncclearn.org/resources/library/nama-on-afforestation-of-degraded-land-riverside-areas-and-protection-belts-in-the-republic-of-moldova/

[57] ICAS (FRMI), 2022, Draft version of the updated study for the assessment of the current state of forest nurseries

Since poverty is concentrated in rural areas where livelihoods depend on agriculture and livestock, the current use of lands is, in general, perceived as a need for the subsistence of rural households. Most of the degraded lands are used as pastureland for cattle and afforestation of these lands is regraded in competition with livestock activities. Due to the low quality of pastureland in many communities, cattle are grazing in forests which negatively impacts forest restoration.

One key factor in addressing this issue is the involvement of local decisional factors in the planning process as most of the remaining degraded land suitable for afforestation is communal land under the administration of LPAs. An integrative approach to communal land planning is more likely to be successful if afforestation projects are supported by alternative measures, e.g. to increase the productivity of existing pastureland. As the Forest Code lacks chapters relevant to the administration and management of public forest properties owned by LPAs, the involvement of local administration in the afforestation projects has to address a more explicit legal framework for the management and use of the afforested lands.

The establishment of forest plantations on private land and the involvement of the private sector in the expansion of forest areas is limited as currently, forest ownership culture has not developed yet in the Republic of Moldova. Appropriate subsidy mechanisms must tackle the non-willingness of private land owners to adhere to the afforestation plans. In the context of increased insecurity of energy sources, the potential firewood markets from private forest lands can act as an incentive for entrepreneurial activities in the afforestation of private lands.

The implementation of the afforestation plans suffered from drawbacks in the last decade, caused especially by the lack of financial means and the poor capacity to convince local public authorities and private landowners of the high potential benefits of afforestation measures compared to the current land use.

6.4. Challenges of Moldova in future afforestation and forest landscape restoration

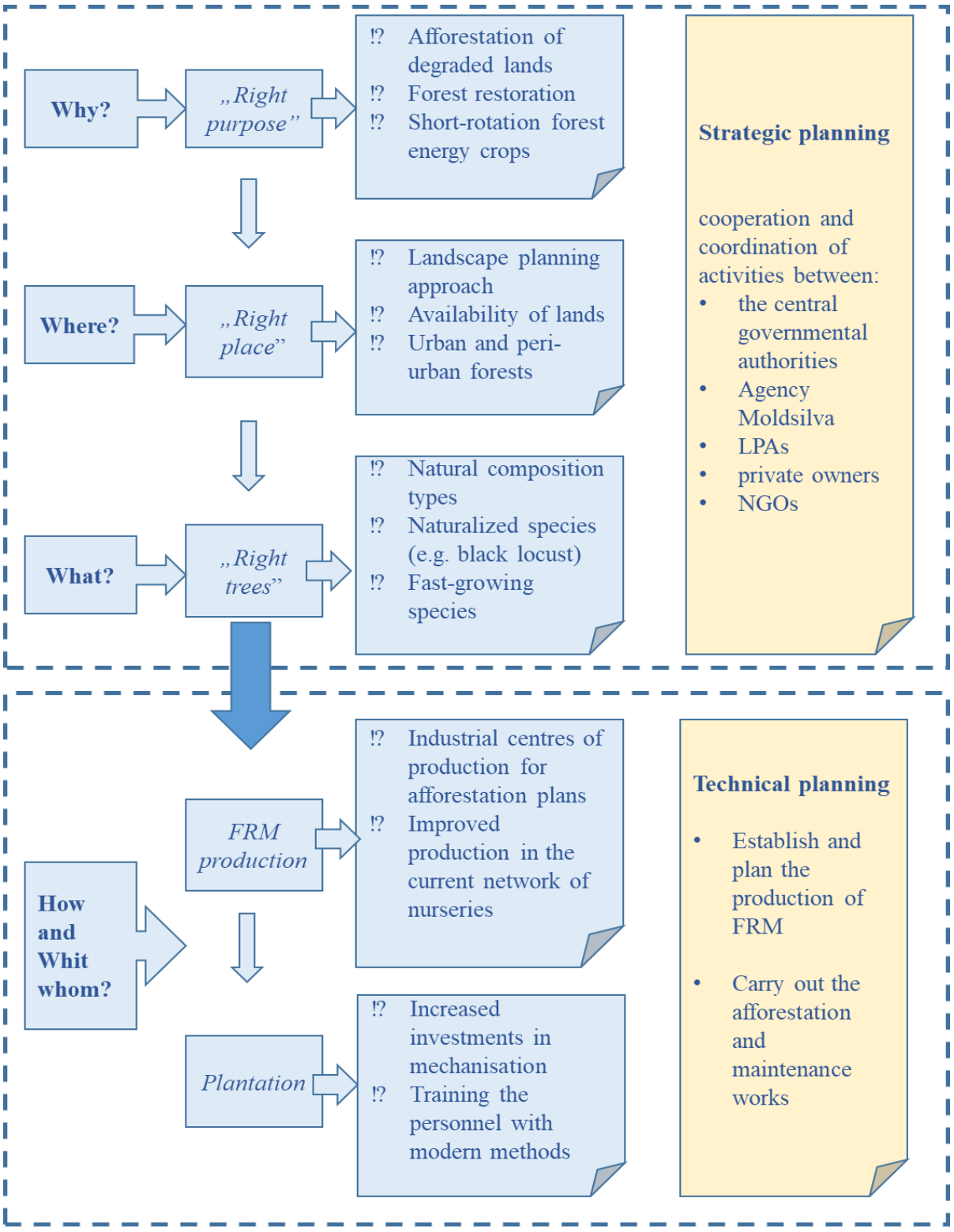
The Republic of Moldova has set ambitious targets for the afforestation of about 100 thousand ha of land by 2030. Despite its proven capacity to implement afforestation plans, confirmed by the implementation of several afforestation projects in the last 20 years, implementing the current national plan is subject to several strategic and technical challenges (figure 13). The lack of synergies between strategic and technical planning can result in important bottlenecks for reaching the assumed targets.

The strategic planning needs to respond to the same general aim set by the European forest strategy 2030: **planting and growing the right tree in the right place and for the right purpose**.

The "right purpose" is generally included in the national strategic documents, and it is supported by the assessments made by different international organizations: **afforestation plans need to address with high priority the degraded lands**, considering the high share of such lands in the Republic of Moldova and the high costs of inaction. Nevertheless, two additional objectives are found in the National Development Strategy "Moldova 2030"[58]: 1) t**he creation of stable forest ecosystems by restoring their natural types** of species composition, and 2) **the creation of fast-growing tree plantations** for the energy needs of the population, as a solution to address the high demand for firewood in rural communities and to tackle the illegal logging. However, the National plan for afforestation 2030 is not specific about the last two objectives and their integration in the action plan (e.g. areas envisaged, methods to be used etc). Attaching clear targets to each area of the policy objectives is essential to decide on the type of species that FRM production has to integrate.

Figure 13. Strategic and technical challenges in afforestation and forest landscape restoration plans

[58] https://particip.gov.md/ro/strategy/strategia-nationala-de-dezvoltare-moldova-2030/4



The selection of land ("the right place") is subsequently linked to the capacity to set clear area targets for the afforestation objectives. The landscape planning approach is advocated by most international organizations (e.g. UNEP, 2016) considering that such an approach will address the current drivers of land and forest degradation in an integrative manner. Likewise, the approach will contribute to the creation of interconnected corridors between forest bodies, an objective also recently assumed by the National Development Strategy "Moldova 2030". Nevertheless, as explained in the previous sub-section, the availability of land, more specifically the willingness to change the land use from agricultural use to forest plantations, is the most critical constraint factor for the successful implementation of afforestation projects. Under these conditions, it is more likely that implementing the current afforestation plan will start with

prioritized areas where the owners (LPAs or private owners) are convinced to dedicate their degraded lands to forest plantations. The landscape planning approach is becoming essential in directing the financial and capacity-building resources to those areas where the need for afforestation is high.

Different decisional challenges are identified in the assessed documents regarding the selection of land. The World Bank Forestry Note considers that to reduce the conflict with agricultural use, a selection criterion can be set so that the afforestation activities can only take place in areas classified in the National Cadaster as degraded land with productivity class (bonitet) <40, to ensure that productive land remains available for agriculture.

From a legal perspective, an important decision is related to the distribution of property rights for the afforested lands. Integrating the afforested lands in the National Forest Grounds has important benefits. This includes e.g., the need for forest management plans, the impact on the rotation age and the irreversible land use changes. This approach can reduce the capacity to convince LPAs and forest owners to offer their lands for the afforestation projects. Creating clear mechanisms for LPAs and private owners with regard to sustainable development, utilization, regeneration, protection and guarding of afforested lands, jointly with State Forest institutions, is a central part of the strategic planning.

The selection of species ("the right trees") links strategic and technical planning. The selection of tree species is important to build healthy and resilient ecosystems that can also withstand current and future threats such as climate change. From a technical perspective, the selection of trees to be planted is established by the technical guidance on the afforestation of degraded lands developed by FRMI in 2015[59]. The guidance provides trees and shrubs species depending on the region and the type of degraded land.

The approach to forest landscape restoration opens some debates regarding the selection of species for afforestation projects, especially about some introduced species which are largely used in forestry and by households. The main example is the black locust (*Robinia pseudoacacia*), which seems to be almost naturalized and is highly preferred by local communities for fuelwood and agricultural needs as well as for other purposes (beekeeping, food). This is also reflected in the current FRM production, where black locust has a constant share of about 50% in the total production of seedlings.

Considering that most of the degraded lands belong to LPAs and private owners, an important challenge is to find the species that can meet both, the owners' expectations and the forest restoration objectives. Most landowners will favour fast-growing species, especially since biomass for energy purposes is becoming an attractive investment. One approach is to create different afforestation mechanisms, in which the forest restoration approaches on communal and private lands are rewarded with a higher subsidy scheme compared to the fast-growing tree plantations.

The FRM production is thus embedded in a set of strategic decisions that need to be considered e.g. to set the species assortments and the yearly production capacities. The production of the necessary number of seedlings per species cannot be done from one year to another. Consequently, the afforestation plan has to better define the species composition as an input to set the production capacities. The assessment shows a decrease of the current production capacities in the last decade to a minimum that can cover mainly the needs of the Moldsilva Agency for the reforestation. This is also reflected in the fact that some international donors (e.g. UFAD) have problems in implementing afforestation projects because of a shortage in seedlings, even when adequate financial means for seedling acquisition are provided.

[59] FRMI.2015. Technical guidelines for the afforestation of degraded lands (in Romanian): http://www.moldsilva.gov.md/public/files/1111/Hotarirea_Consiliului_Tehnico-Stiintific_din_20.02.2015.pdf

The Republic of Moldova has a large area of nurseries compared to its forest cover, allowing it to develop a production of saplings that exceeds the internal need for reforestation of the Moldsilva Agency.

Compared with other countries e.g. Romania, the potential capacity of saplings production in Moldavian nurseries is much higher. Romania has 227 ha of nurseries for every million hectares of forest, while in the Republic of Moldova, considering the total area of nurseries of 990 ha, which would give 2 145 ha of nurseries for one million hectares of forest. If only the cultivated area of nurseries is considered (630 ha), the result would be 1 365 ha per one million hectares of forest.

Even if one considered the number of saplings produced in nurseries compared to 100 ha of forest cover, the Republic of Moldova confirms a solid potential for sapling production. In 2006, there were 12.8 thousand saplings produced per 100 ha of forest cover. However, in 2017 this value dropped to 2.9 thousand saplings, but still indicated a solid production capacity. By comparison, Romania produces approximately 550 saplings per 100 ha of forest cover, Finland 750, Iceland 1.8 thousand, Sweden 1.4 thousand, and Turkey 2 thousand.

The main challenges in FRM production are to change the current approach by centralizing the production of seedlings for afforestation projects in three main industrial centres for production. The initially proposed approach by the World Bank Climate has been acknowledged as a solution for implementing the current national afforestation plans. A draft evaluation of the current state of forest nurseries and the identification of forest nurseries for the establishment of centres for the industrial production of forest saplings has been performed by the FRMI (see subchapter 5.2.2.).

The shortage of skilled labour force impacts not only FRM production but also the capacity to perform planting activities. According to the national regulatory framework, afforestation activities are carried out by Moldsilva Agency and LPAs. However, afforestation on community land is often conducted by Moldsilva Agency since many communities lack the resources and knowledge to carry out the work by themselves. The experience of other countries shows that planting activities can also be open to market competition. Considering the ambitious targets set in the NARP, assuring the services for planting the trees can be an important market. Hence, private companies can be more flexible in finding efficient ways of planting to cope with the current labour shortage.

The availability of funding remains a fundamental challenge for afforestation and forest restoration programs, in the Republic of Moldova (WB, 2014, NAMA, 2016). The lack of finance has been an important barrier to scale-up afforestation activities implemented by international donors. This is reflected in the slow progress of reaching the targets on forest cover extension, which are to be achieved through the afforestation of degraded land.

For the NARP different financial sources are considered. The concept note of the Moldsilva Agency considers that the share of the national sources for financing the projects should be around 31% (considering the involvement of GoM, the Ministry of Economy and Investments, the National Ecologic Found and the funds of Moldsilva Agency) while the international sources should cover around 69%.

Special attention should be given to existing projects with international support which have set clear targets and financial means for their implementation but have been delayed (table 10).

Table 10. On-going programs with international donors for afforestation programs

Project	Implementing organizations	Estimated budget	Targets
Intelligent climate management of forests and grasslands (PDD)	World Bank Moldsilva FRMI Ministry of Environment	8.8M$	▪ Afforestation of 1 500 ha of degraded lands ▪ Planting 320 ha of riparian protection belts ▪ Planting 560 ha of forest belts for the protection of agricultural fields ▪ Rehabilitation of 750 ha of forest protection belts ▪ Rehabilitation of 1 000 ha of degraded grasslands
Nationally Appropriate Mitigation Actions (NAMA) in Forestry	UNDP Moldsilva FRMI	127M$	▪ Afforestation of 45 000 ha of degraded lands ▪ Planting 15 000 ha of riparian protection belts ▪ Planting 1 500 ha of forest belts for the protection of agricultural fields
Prevention and mitigation of effects caused by local floods (PIF)	UNDP MoE FRMI	2.3M$	▪ Afforestation of 658 ha of land within the water and riparian protection areas ▪ Rehabilitation of 214 ha of forest belts for the protection of agricultural fields and water ▪ Creation of 72 ha of wetlands ▪ Development of forest management plans for 3274 ha of forest land ▪ Development of silvopastoral management plans for the total area of 10 214 ha

A critical objective of strategic afforestation planning is also the involvement of stakeholders like the local the population, civil society and the private sector in expanding forest areas. The ambitious afforestation plans have strong media support which is likely to create an interest in the private environment to activate their corporate social responsibility resources in supporting the afforestation plans.

7. Findings and ways forward

7.1. Identification of key missing elements

The Republic of Moldova is in continuous transformation, being directly affected by regional and global events: e.g. the increase in prices for energy and food products, the security crisis in the region, and climate change affecting agricultural production and forest ecosystems. In addition to short-term interventions to deal with current crises, the Government of Moldova has proposed defining a medium and long-term National development strategy for the Republic of Moldova to strengthen resilience to future crises and to create the basis for the country´s sustainable and inclusive development.

The Republic of Moldova has acknowledged in different strategic plans and documents the need to expand its forest area, one of the lowest in Europe. Most plans have set targets that aim to ensure an increase of forest areas to 15-17%. However, these targets have been met only partially in the last two decades, despite the successful implementation of several afforestation projects supported by international organizations. The lack of a stable forest policy framework, the availability of funding and the willingness of land-owners to afforestate agricultural lands were the most significant constraints to the successful implementation of previous strategic afforestation plans.

The National Afforestation and Reforestation Programme for the period of 2023 – 2032 (NARP) has set the ambitious target to increase the forest area by 100 thousand ha by 2032, prioritizing mainly the afforestation of degraded lands but also the restoration of existing forest ecosystems and the plantation of fast-growing forest energy crops.

The afforestation objectives at the national level must be set within the context of the current or predicted capacities of the Moldavian forest sector to carry out afforestation or reforestation projects. Setting clear area targets depending on land availability and defining the purpose of afforestation projects are essential to plan the production of FRM in a relatively short period.

The critical element that determines the feasibility of these projects is the capacity to produce sufficient quantities of FRM. In the specific case of the Republic of Moldova, considering the relatively large area of nurseries, there is great potential for developing a large seedlings´ production capacity. New approaches, new equipment and technologies are needed to update the current state of nurseries and afforestation infrastructure in the Republic of Moldova. However, additional changes in the overall forestry infrastructure are required. Such changes imply not only updating the approach to centralized nurseries, planning activities and providing logistical support for FRM deposits and transfer, but also revising some of the existing normative regulations and training skilled workers.

Moreover, **shortages in financial support for technical developments have led to reduced efficiency in the production of FRM in Moldavian nurseries**. Implementing new production systems or technologies is limited because most forest nurseries are small and have poor production infrastructure. The sapling quantity produced annually has a descending trend from 59 thousand in 2006 to 13 thousand saplings in 2017. The Moldavian tree nurseries' production capacity dropped in 2021 to the lowest in the last two decades. This decline is mainly caused by low or deprecated mechanization and a decreasing labour force. These limitations must be overcome by measures such as introducing innovative techniques, re-organization, modernization, and privatization of forest nurseries.

New equipment and technologies are urgently needed, along with thorough planning and logistical assistance for producing FRM. For example, currently, there is no production of containerised seedlings or with protected root system which might be a solution for successfully implementing forest restoration plans. The creation of industrial centres for FRM production has been chosen as the right approach. Efforts were already underway to identify their location based on a set of economic indicators that can assure their

efficiency. Nevertheless, important organizational and logistic investments are needed which rely on the availability of funds and political support.

Opening private markets for the production of FRM, which is envisaged by the recent legal changes, should also be considered to support FRM production and can speed up the introduction of innovative techniques. The challenge is to provide fair conditions for the competition in this new and still state dominated market.

Moreover, the Moldsilva Agency has been assigned a double role. On the one hand, the Agency is the main FRM producer in the country. On the other hand, it is the legal body in charge of supervision and control authority over all FRM producers. A clearer separation of management and controlling function for FRM production is more prone to allow private producers to get an important share of the market.

The assortment of the species produced in the nurseries and the quality of the seedlings are problematic in the current approach to FRM production. For example, black locust constantly represents about half of the FRM production, and despite its potential utilization as a solution for degraded lands and energy plantations, efforts are needed to increase the share of good quality seedlings of native species to meet the objectives of forest restoration. The concept note for NARP implementation proposes using native species on about 56% of the area to be planted. While this share represents a significant increase compared to the use of native species in previous reforestation and afforestation projects, producing sufficient and good-quality seedling material becomes a challenge considering the current production technologies. The share of non-native species planned to be used in the NARP (about 32%) may be considered high in view of the forest restoration principles. Nevertheless, bearing in mind that the main targeted areas in the NARP are degraded lands, the use of non-native but almost naturalized species can be a solution if efforts are made to plant them only where the use of non-native species is not a viable alternative.

The provenance of the seeds used in nursery production is an important shortcoming since between 2002-2020, on average only 4.5% of the seeds were collected from stands registered in the basic material lists. Compliance with the regulations regarding the production and transfer of FRM is essential in the context of climate change. Especially in areas that are most severely threatened by climate change, FRM transfer and assisted migration might be valuable options for adapting forests to the new climate realities. Tree breeding offers innovative opportunities for forestry under climate change. **Therefore, provenance experiments are crucial in the following years. There is a critical need for more studies to understand the adaptive genetic potential of forest tree and their response to environmental changes**. As many local environmental conditions change rapidly, foresters should extend their options to both local and non-local FRM, considering favouring provenances instead of species in assisted migration schemes.

7.2. Possible ways forward for forest landscape restoration and FRM production

In line with the identified missing key elements, the study on FRM production in the Republic of Moldova results in several findings, both at the strategic planning level and the specific technical planning.

The strategic planning of the NARP 2032 needs to set clear area targets for each of the policy objectives: afforestation of degraded lands, restoration of existing ecosystems, forest plantations for energy purposes, and urban and peri-urban forests. This is a prerequisite to plan the type of species that FRM production has to integrate. Moreover, the elaboration of the long-term, large-scale strategy with clearly defined priorities based on a large political agreement can create a better framework for the integration of small-scale, externally funded, afforestation projects that would contribute to the NARP by addressing its top-rated objectives.

Align the strategic planning with the EU requirements on forest restoration while considering the current efforts for adapting the legislation to the European context. This will involve setting requirements

for species and ecotypes to be climate-resilient and without negative impact on biodiversity. The priority is to update guidelines on tree planting in the Republic of Moldova to also create safeguards, in particular, to exclude the use or release of invasive alien species. In addition, the FRM production needs to target tree species and ecotypes suitable for Moldova's future projected climatic conditions in sufficient quantities.

A landscape approach is needed for the integration of the objectives of the afforestation plans[60]. In addition to the efforts to plant on degraded lands, **targets for urban afforestation** are needed. These need to be achieved through a landscape-level approach that contributes to strengthening connectivity among natural or semi-natural areas (such as forests, urban, peri-urban or agricultural areas) with a focus on linking habitats through green infrastructure and ecological corridors. The main constraint in implementing the plan is the willingness of owners to change the current agricultural use of land. A bottom-up approach for the planning can be supported in the initial phase and can integrate the currently available land and require fewer institutional efforts. Subsequently, additional institutional and financial mechanisms can enhance the process of convincing the landowners to adhere to afforestation projects.

The landscape planning approach allows **the consideration of natural forest expansion on agricultural land.** Especially on abandoned agricultural land adjacent to forest complexes, where the spontaneous forest vegetation expands naturally. A preliminary identification of this land (e.g. based on remote sensing tools) allows prioritising the financial resources for (i) covering investment in forestry works for young stands' management (e.g. plantation, cleaning, pre-thinning) and (ii) creating subsidy schemes for private owners and LPAs owning the land to compensate for the agricultural revenue lost and for the forest ecosystem services provided.

The successful implementation of the small-scale forest restoration projects needs to be replicated and used as an argument to convince land owners of the overall potential benefits of and synergies between agricultural use, water availability, soil protection and climate change mitigations. Media campaigns and the involvement of the private sector in support of the national afforestation plan can increase its chance of success.

The seed base material list needs to be adequately used in the production of FRM. This involves a clear procedure for identifying the stands from which the seeds will be harvested and the anticipated assessment of the needs for seeds, the evaluation and monitoring of forest seed harvested, the organization of warehouses for longer-term seed storage and the planning for possible import of a missing FRM (seeds or seedlings).

The technical planning of FRM production, in industrial centres and the existing network of nurseries, needs to consider the following aspects:

- review of technologies for the production of seedling materials to respond to the desired species selection foreseen in the afforestation plan;
- provide planting material with protected roots system for at least 3-5 million seedlings in the next five years to increase the chance of success for the forest restoration projects;
- install modern irrigation systems for efficient water use, as the water shortage in nurseries is proven to be a significant constraint for efficient seedling production;
- renew the equipment and types of machinery used in nurseries, as labour shortage is strongly impacting the current production techniques; this involves the procurement of sowing machines, drilling machines for the pruning section, seedling production lines in containers etc;

[60] See more in the National Policy Guiding Principles for Forest Landscape Restoration (UNECE/FAO, 2022)

- ensure qualified personnel in the nurseries and the field, provide training courses on the new technologies and methods as well as financial stimulations to reward the plans´ implementations.

7.3. Possible next steps in the development of the FRM sector in Moldova

Considering the identified constraints, additional inputs are needed at the strategic level e.g. (i) to support implementing a landscape planning approach for the afforestation projects, (ii) to align the strategic planning with the EU requirements on forest restoration and (iii) to set clear guidelines on the type of species to be used according to afforestation goals. In sum, the main improvements recommended by this study are:

- Development of the FRM sector must be tightly linked with the overall NARP strategy by setting clear areas targets for each of the policy objectives: afforestation of degraded lands, restoration of existing ecosystems, forest plantations for energy purposes, and urban and peri-urban forests.
- The NARP strategy should be developed and further elaborated into more detailed activities. The landscape planning approach should be connected with e.g. land available for afforestation, the provisions of forest management plans, the social needs etc. with given hierarchical priorities e.g. depending on urgency, expected benefit, effect/cost factor, probability of success, etc.
- Implementation of the NARP should be consecutive (with an adaptable pace, adjusted to available resources) and comprehensive. The plan has to cover the whole chain of production including its main components e.g. availability of land, proper planning (function, species composition), availability of seeds, seedling production capacity, planting capacity, and financial and technical support to landowners.
    - The concentration of resources and efforts as well as choosing smaller but well-funded and supported projects would help to improve efficiency, success and sustainability of the measures undertaken, serving as examples, and spreading good practice and knowledge.
    - For the technical planning of FRM development, an in-depth cost-benefit assessment is needed, based on an improved set of indicators, to identify the efficiency of the existing network of nurseries and to establish industrial centres for FRM production. This analysis implies a proposed technical design of the industrial centres' production section, which is to be determined by an accurate estimation of the number of seedlings required for implementing the NARP 2032.

Undoubtedly there is a significant political and societal interest in afforestation activities in the Republic of Moldova. However, filling the gaps in the national afforestation plan requires the common support of decision-making and technical planning entities. The NARP 2032 can guide the assistance provided by the development partners of the Republic of Moldova in relation to the national development priorities, create synergies and ensure better coordination of their projects and resources. Furthermore, the NARP 2032 could become a starting point for mobilizing private resources and fostering ideas, initiatives and projects in which civil society organizations and the national scientific community could be involved.

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