THE SECOND REPORT ON THE STATE OF THE WORLD'S FOREST GENETIC RESOURCES

COUNTRY REPORT

BULGARIA

This country report was prepared as a contribution to the FAO publication, *The Second Report on the State of the World's Forest Genetic Resources*.

The country reports had two elements: (1) an online questionnaire to gather data and information on forest genetic resources; and (2) a complementary written report. For the written reports, countries were invited to follow the structure of the global report and reporting guidelines adopted by the Commission on Genetic Resources for Food and Agriculture at its Seventeenth Regular Session in 2019.

EXECUTIVE FOREST AGENCY

FOREST SEED CONTROL STATION-SOFIA

SECOND REPORT ON THE STATE OF THE WORLD'S FOREST GENETIC RESOURCES

BULGARIA

July, 2019

« Forest genetic resources are the heritable materials maintained within and among tree and other woody plant species that are of actual or potential economic, environmental, scientific or societal value. […]. Most tree species have high levels of genetic diversity, offering great potential for increasing the production of both wood and non-wood forest products, as well as for improving the provision of environmental services."

FAO, 2019

Introduction

At its Sixteenth Regular session in 2017, the Commission adopted targets, indicators and verifiers for forest genetic resources (FGR) to be used as assessment tools to monitor the implementation of the Global Plan of Action. The Commission also adopted a schedule for monitoring the implementation of the Global Plan of Action, including the main steps required for the preparation of The Second Report on the State of the World's Forest Genetic Resources**.**

The report constitutes Bulgarian contribution to the second FAO report on the state of forest genetic resources and follows the guidelines given by FAO.

Summary

Forest genetic resources are extremely important for human life as an essential component of the environment. The forests in Bulgaria are part of the European and world forest wealth. In recent years, the total area of forest territories in our country is constantly increasing and at the end of 2019 it amounted 4 149 351 ha, or 37.4% of the country's territory. From 2009 to the end of 2019 the total area of forest areas has increased by 18,455 ha.

The assessment of the state of forest genetic resources is carried out during the inventory of all forests over a 10-year period. The research to assess the genetic variability of forest tree species was performed on 38 species (10 coniferous and 28 deciduous) with an emphasis on intraspecific variability, determining totally 449 varieties and forms (118 at coniferous and 331 at deciduous species). 37 ecotypes were evaluated and 57 provenance trials established, including 260 provenances and 29 progeny tests. Genetic analyzes through biochemical markers for 9 tree species were performed and through DNA markers - for 6 tree species.

The number of clones selected is 1445, while the number of clones used – 671, moreover with domination of coniferous species. Monitoring of the state of forest genetic resources in the country shows that it is stable.

In Bulgaria the activities for protection and sustainable use of forest genetic resources are carried out by the Executive Forest Agency, Forest Seed Control Stations-Sofia and Plovdiv, University of Forestry-Sofia and Forest Research Institute at the Bulgarian Academy of Science. The above mentioned institutions have worked on 15 projects in the field of forest genetic resources.

The genetic resources of forest tree species are preserved *in situ* in the places of their natural distribution. An important contribution to the genetic conservation of forest tree species *in situ* have National parks - Rila, Pirin and Central Balkan with a total area of 193,000 ha and eleven Nature parks - Bulgarka, Vratchanski Balkan, Rila Monastery, Vitosha, Persina, Sinite Kamani, Strandzha, Shumen Plateau, Rusenski Lom, Zlatni pyasatsi and Belasitsa, with a total area of 256,441.4 ha and 90 reserves and maintained reserves.

All indigineous/native and other woody forest species conserved *in situ* include mainly the forest area of national parks, nature parks, reserves and seed production stands. Their share 11 % from the total forest cover in the country. The area of in situ preserved species on the territory of the country is 35599.6 ha, including 24 tree species, 8 of which are coniferous with an area of 22065.5 ha and 16 broadleaf species with an area of 13534.1 ha.

Forest genetic resources are stored *ex situ* in 4 clonal collections, 56 seed production orchards, 41 parents of family and 39 stool beds.

In Bulgaria, 16 regions of origin have been identified, having the names of forest subregions.

Acknoledgements

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Abbreviations

FAO – Food and agriculture organization
FSCS-Sofia – Forest Seed Control Station - Sofia
EFA – Executive Forest Agency
DNPCB – Directorate National Park "Central Balkan"
DNPP – Directorate National Park "Pirin"
DNPR – Directorate National Park "Rila"
MA – Ministry of agriculture
OECD - Organisation for Economic Co-operation and Development
FSB - Forest seed production base
FGR – Forest genetic resources
FRM – Forest reproductive materials
SO – Seed orchards
NSDFSRB – National Strategy for the Development of the Foirest Sector in the Republic of Bulgaria

Content

Introduction

Acknolidgements

Abbreviations

Content

Part 1 - The contribution of forest genetic resources to sustainable development

Chapter 1 - Value and importance of forest genetic resources

Part 2 - State of diversity in forests and woodlands

Chapter 2 - State of forests

Part 1- The contribution of forest genetic resources to sustainable development

Chapter 3 - State of other wooded lands

Chapter 4 – State of diversity between trees and other woody plant species

Chapter 5 – State of diversity within trees and other woody plants species

Part 3 – State of forest genetic resources conservation

Chapter 6 – *In situ* conservation of forest genetic resources

Chapter 7 – *Ex situ* conservation of forest genetic resources

Part 4 – State of use, development and management of forest genetic resources

Chapter 8 –The state of use of forest genetic resources

Chapter 9 – The state of genetic improvement and breeding programmes

Chapter 10 – Management of forest genetic resources

Part 5 - State of capacities and polices

Chapter 11 - Institutional framework for the conservation, use and development of forest genetic resources

Chapter 12 – International and regional cooperation on forest genetic resources

Part 6 – Challenges and opportunities

Chapter 13 – Recommended actions for the future

References

Annexes

PART 1: THE CONTRIBUTION OF FOREST GENETIC RESOURCES TO SUSTAINABLE DEVELOPMENT

Chapter 1 Value and importance of forest genetic resources

The forests in Bulgaria perform many social, ecological and economic functions of grait importance for the sustainable development of the country. They are a major factor, a source of renewable forest products and shelter for unique wildlife, biodiversity and genetic resources. Forests play an important role in the process of climate formation and change, reduce the negative impact of climate change and enshure protection against soil erosion, floods, landslides, etc. In social aspect they provide excellent conditions and opportunities for recreation and various types of tourism.

Covering over 1/3 of the territory of the country, forests provide livelihoods for a large part of the population, especially in rural areas, and provide wood and non-wood resources for forestry and related industries. Sustainable management of forest ecosystems is particularly important for the prevention of natural disasters and fires.

The forest genetic resources are extremely important for human life as an essential component of the environment. That is why getting to know and protecting it is one of the prerequisites for protecting the environment.

Wood production

The total wood annual harvesting for 2019 is 8 007 915 m^3. 3 627 126 m^3 were harvested from the regeneration fellings, which is 78.08 % of planed regeneration fellings (4 645 648 m^3) according to the forestry management plans. 4 380 789 m^3 were harvested from thinnings, which represents 54.71% of total harvest, 50,24 % of the volume planed in forest management plan and is 107,52 % of planed thinnings (4 074 109 m^3) in forest management plan.

The annual harvest in state owned forest areas is 6 024 166 m^3 standing timber, which is equal to 92,42 % of the planed volume in forest management plans (6 517 850 m^3 standing timber). The biggest part of harvested wood is for fuelwood – 4 09 423 m^3 [Table 1], from 71 coniferous and 29 broadleaf species. The main type of forests used for industrial wood are high stem oak, high beech forests and poplar plantations.

Table 1 Total wood production from regeneration fellings and thinnings without forests on agricultural land

	Type of wood material (m^3)					
	small-sized timber	Medium-sized timber	Large-sized timber	Total of industrial wood	fuelwood	branches
Planned	1 491 918	1 607 505	469 903	3 569 326	3 347 888	219 082
Harvested	1 361 560	1 066 264	137 422	2 565 246	4 095 423	10 687
Incl. industrial harvesting	1 218 621	934 687	118 616	2 271 924	3 007 800	4 339
Incl. dry and follen wood	68 334	31 469	1 722	101 525	188 605	178
Incl. sanitary fellings	176 891	316 450	33 137	526 478	612 249	3 816

Non-wood forest products

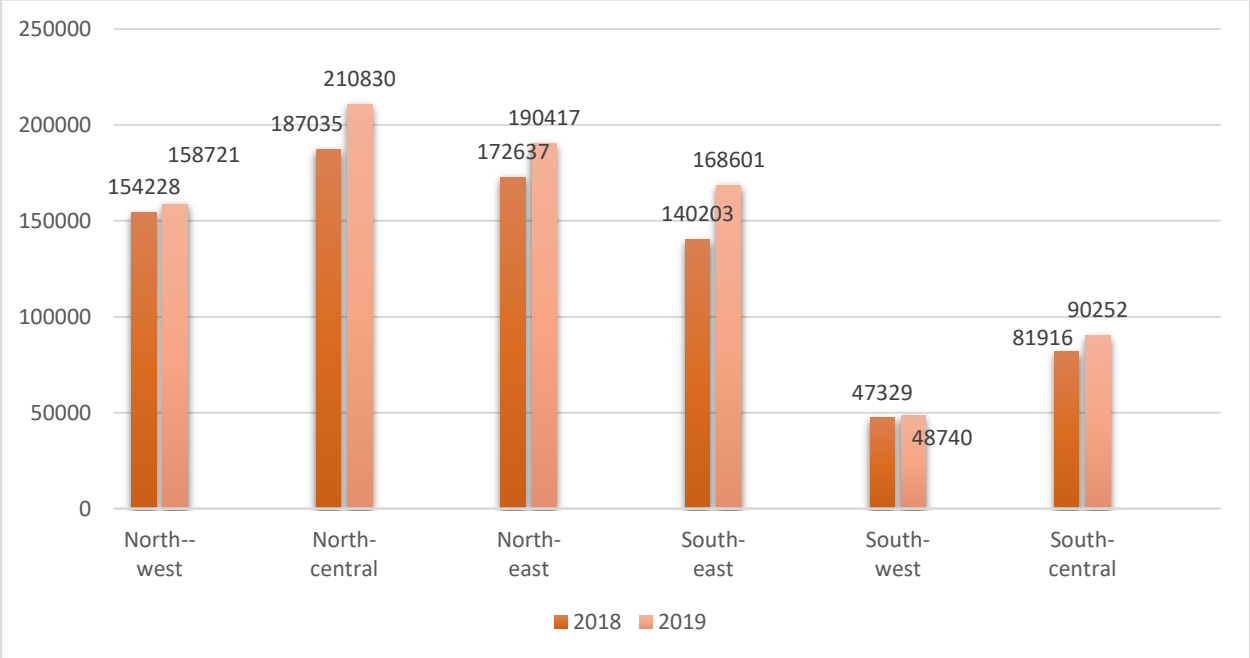
FAO defines NWFPs as "Goods derived from forests that are tangible and physical objects of biological origin other than wood". The main products with available information are presented below (forest seeds, forest plants, honey and game). In 2019 State forest and hunting enterpises collected 43 732 kg seeds and produced 11, 5936 million seedlings.

The long traditions and the suitable natural, climatic and ecological conditions in Bulgaria favor the development of beekeeping. Given the irreplaceable healing properties of honey and bee products, there is increased interest and demand from consumers, and the good quality parameters of Bulgarian honey make it largely export-oriented.

Beekeeping is an alternative employment for the population in underdeveloped rural areas, providing additional income. The sector has been positively affected by the already implemented fourth consecutive three-year National Beekeeping Program, which is being developed with the broad participation of branch beekeeping organizations.

As of October 1, 2019, there are 13 771 bee farms in the country, where 867 561 bee families are kept. The average number of bee families on a farm is 63.

Fig. 1. Number of bee families by regions (2018, 2019)



In 2019, the number of honey families from which honey was extracted reached 702 851 - 14.5% more than the previous year. With a slight decrease in the average yield of a bee family (16.4 kg), the production of honey increased by 11.4% to 11 518 tons**.**

The realization of honey and the average selling prices (excluding VAT) in 2019 are as follows:

- Direct sales to the end user – 1 779 tons - BGN 7.13 / kg;
- Direct sales to retailers - 307 tons - BGN 6.21 / kg;
- Sales to processing enterprises – 3 734 tons - BGN 4.18 / kg;
- Sales for industry - 454 tons - BGN 4.04 / kg;

In general, the health status of the game in Bulgaria is good, despite the epidemic of African plague in 2018-2019, transmitted by wild boars. In 2019, efforts are focused on combating poaching in all its forms. The work on reaching the admissible stocks continues. Selection in populations is also among the main tasks for this year, as it is a major prerequisite for obtaining quality trophies.
The analysis of the results of the game taxation shows that the stocks of the predominant part of the big and small game populations are increasing.

Table 2 Taxation and use of game (number)

№	Game	Taxation stock			Use total		
		2017	2018	2019	2017	2018	2019
Big game							
1	Red deer	27914	29585	31233	751	836	1033
2	European fallow deer	8544	9421	9761	1087	1082	1166
3	Roe deer	110944	116697	121136	2220	1571	1734
4	Wild boar	94865	100065	97690	45265	45395	40556
5	Mouflon	4043	4274	4415	115	147	149
6	Chamois	2100	2267	2505	48	50	38
7	European bison	32	36	48		2	
8	Brown bear	981	943	1003			
9	Western capercaillie	3249	3229	3303	33	49	46
10	Wild turkey	130	85	140	3	1	47
Small game							
11	Hare	350781	351855	353264	7266	4792	4315
12	Hare - control	228999	182770	192609			
13	Ring-necked Pheasant	163166	171871	180545	34240	34756	31792
14	Grey partridge	332751	324257	324923	34492	26172	21961
15	Chukar partridge	7719	7823	7034	242	239	
16	Rock partridge	10596	11007	10567	2		

Forests also provide ecosystem services that are a source of specific ecological, social and cultural values. The benefits provided by forest ecosystems include commodities such as timber, food, fuel and

organic products; environmental functions such as carbon storage, nutrient circulation, water and air purification and wildlife habitat maintenance and social and cultural benefits such as recreation, traditional resource use and spirituality.

A methodology for assessment and mapping of ecosystem services has been developed.

It is part of the national methodological framework for mapping and assessing the state of ecosystems and the ecosystem services they provide. The framework aims to optimize the overall process of defining, mapping and biophysical assessment of ecosystems and the ecosystem services they provide at national level. The methodology is not directed at completion of the full cycle of ecosystem services assessment and reporting. It provides the sequence, step-by-step and practical guidelines for the process of: Assessment of the state of forest ecosystems and Assessement of the potential of forest ecosystems to provide ecosystem services (biophysical assessment).

With the provision of numerous ecosystem products and services, forest genetic resources are attracting growing interest from the stakeholders in forest sector and civil society. Bulgaria pursues a national forest policy aimed at maintaining and improving forest genetic resources, in particular by supporting the conservation of biological diversity, the research described in Chapter 10.

PART 2: STATE OF DIVERSITY IN FORESTS AND WOODLANDS

Chapter 2 State of forests

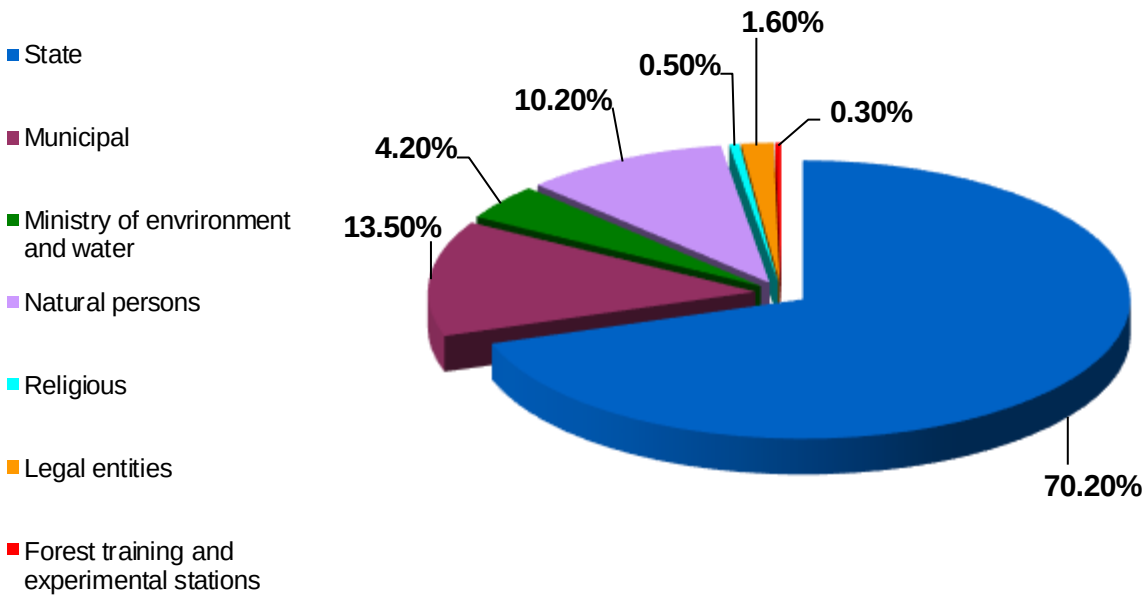
The forests in Bulgaria are part of the European and world forest wealth. In recent years, the total area of forest territories in our country is constantly increasing and at the end of 2019 it amounted 4 149 351 ha, or 37.4% of the country's territory. From 2009 to the end of 2019 the total area of forest areas has increased by 18 455 ha.

The state forest territories at the end of 2019 have an area of 3 096 056 ha (74.62%) of which 2 912 371 ha (70.19%) - forest territories managed by state enterprises under Art. 163 of the Forest Act, 172 417 ha (4.16%) - forest territories managed by the Ministry of Environment and Water (including National Parks “Rila”, “Pirin” and “Central Balkan” and Reserves) and 11 268 ha (0.27%) - forest territories managed by the Forest training and experimental stations – “Yundola” and “Barzia”.

The non-state forest territories cover an area of 1 053 295 ha (25.38%), of which 561 595 ha (13.53%) are municipal forest territories, 424 252 ha (10.22%) - forest territories owned by natural persons, 67 448 ha (1.63%) - forest territories owned by legal entities and 19 195 ha (0.46%) - forest territories owned by religious communities. Private property in the forest sector is not a small part of the area of Bulgarian forests. Most of the private forest properties have an area of up to 2.0 ha and the property is highly fragmented, which is why private forests have been purchased by the state in the last year.

The agricultural territories, which have acquired the character of a forest in the sense of art. 2, para. 1 of the Forest Act, cover an area of 116 766 ha.

Fig. 2 Distribution of forest territories by type of ownership



Bulgarian forests are characterized by extremely rich biodiversity of coniferous and broadleaf tree species. The distribution of the forest area by forest types follows a characteristic trend of permanent reduction of the area of coniferous forests and coniferous plantations, which as a result of large-scale afforestation programs in the middle of the last century was sharply increased. The afforested area of coniferous forests is declining, which, despite the appearance of self-afforested areas, is due to the continuing attenuation of some of the mixed coniferous-deciduous stands obtained after the creation of coniferous plantations, evidenced by the forest inventory in Forest and Hunting enterprises in recent years and through the implementation of a policy for the transformation of coniferous plantations established outside their natural areal. This trend will continue in the future.

There is a tendency to increase deciduous high-stem forests due to the conversion of coppice plantations into high-stem stands, afforestation of burned forest areas, areas affected by windthrows and others, self-afforestation of unforested areas, reassessment of coniferous plantations and of the stands with low productivity and transformation of coniferous forests into broadleaved forests.

The silvicultural activities in the Bulgarian forests are aimed at preserving and increasing the basic functions of the forests, giving priority to natural regeneration, protection of genetic resources, maintenance and restoration of biological diversity, etc. Maximum utilization of the natural regenerative potential of forests and its support are the basis of all forestry activities related to forest management. The maintenance of the natural (bioecological) functions of forests is at the same time a condition for the economic sustainability of the forest sector, as the protection and the production are equally important for the society. The balance between the average annual increment and the average annual wood utilization is one of the most important indicators for the assessessment of sustainable forest management.

Sustainable forest management means the use of forests and forest territpries in a way and size that maintains their biodiversity, productivity, recovery capacity, vitality and potential to perform, now and in the future, environmental, economic and social functions on local, national and global level, and not harm other ecosystems.

The management, use and protection of forests in recent years are directed to forming and maintaining vital and multifunctional forest ecosystems, creating conditions for their natural regeneration and improving their resilience. The regulation of the tree composition and the improvement of the growth conditions through control during the thinnings (including felling systems for individual production of high quality wood) and control of the regeneration fellings with natural seed regeneration provided in the forest managament plans (incl. selective fellings), and the conversion of coppice forests into seed forests directly affect the quality of the stands.

Maintaining a favorable conservation status of forest habitat types, conducting trainings, information campaigns and other events with the participation of structures and specialized territorial units of EFA, NGOs and other stakeholders interested in the state of Bulgarian forests are the way to sustainable development.

Forest monitoring of pests and diseases and forecasting of gradations and epiphytotics provide an opportunity to improve the quality of the stands.

Certified forest territories in Bulgaria currently have a certificate from the Forest Stewardship Council - FSC (Forest Management Council). According to EFA data, the area of the certified forest territories as of December 2019 is 1 454 068 ha, equal to 35% of the total forest territory in the country and the certified units are 25. 482 certified units have a FSC - Chain of custody.

The area of the certified state forest territories managed by the State forest enterprises is 1 438 694.9 ha, equal to 50% of the total territory managed by them in the country and the certified units are 25.
According to the electronic information portal of The Program for the Endorsement of Forest Certification - PEFC (Forest Certification Program), 19 certified units have a PEFC - Chain of custody.

Chapter 3: State of other wooded lands

Mountain pine (Pinus mugo) is classified in the category “Other wooded land”. Pinus mugo forms the upper forest limit in the mountain areas in the country and covers 23 885 ha. The upper forest limit in high mountains regulates surface water runoff and avalanches, maintains the water flow of rivers, reduces the spring floods, and prevents roads and settlements. Due to the fact that this type of forests have a solely water protective function, forestry practices are not recommended. If necessary, the activities should imitate the natural dynamics and restoration processes of the ecosystems.

Chapter 4 State of diversity between trees and other woody plant species

In Bulgaria, 54 tree and shrub species have been identified as “forest genetic resources”. The indigenous species predominate - 39 in number and 15 non-indigenous. The number and distribution of tree species in the country is stable.
Shrub ecosystems in our country are in good condition. There are about 30 plant species. Three subtypes of shrub ecosystems are distinguished, the most common being temperate-continental and Mediterranean-mountain shrubs, which are 98 % of the total. They are dominated by hawthorn, dog rose, dogwood, blackthorn, brambles and red raspberry. Although experts report a decrease in some municipalities, their overall distribution is wide.

Table 3 Indigenous and non-indigenous species defined as "forest genetic resource"

Latin name of the species	**Name of the species in english**	**Origin**
Abies alba	European silver fir	indigenous
Abies pinsapo	Spanish fir	Non-indigenous
Acer campestre	Field maple	Indigenous
Acer platanoides	Norway maple	Indigenous
Acer pseudoplatanus	Sycamore maple	Indigenous
Alnus glutinosa	Common alder (European black ader)	indigenous
Betula pendula	Silver birch (European white birch)	Indigenous
Carpinus betulus	European or common hornbeam	Indigenous
Carpinus orientalis	Oriental hornbeam	Indigenous
Castanea sativa	Sweet chestnut	Indigenous
Cedrus atlantica	Atlas cedar	Non-indigenous
Cedrus libani	Lebanese cedar	Non-indigenous

Corylus colurna	Turkish hazel	Indigenous
Fagus orientalis	Oriental beech	Indigenous
Fagus sylvatica	European beech	Indigenous
Fraxinus angustifolia	Narrow-leaved ash	Non-indigenous
Fraxinus excelsior	European ash	Indigenous
Fraxinus ornus	Manna ash (South European flowering ash)	Indigenous
Gleditsia triacanthos	Thorny honeylocust	Non-indigenous
Juglans nigra	Eastern black walnut	Non-indigenous
Juniperus excelsa	Greek juniper	Indigenous
Larix decidua	European larch	Non-indigenous
Ostrya carpinifolia	European hop-hornbeam	Indigenous
Picea abies	Norway spruce	Indigenous
Picea pungens	Blue spruce	Non-indigenous
Pinus heldreichii	Bosnian pine	Indigenous
Pinus mugo	Dwarf mountain pine	Indigenous
Pinus nigra	Black pine	Indigenous
Pinus peuce	Macedonian pine	Indigenous
Pinus pinaster	Maritime pine	Non-indigenous
Pinus radiata	Monterey pine	Non-indigenous
Pinus sylvestris	Scots pine	Indigenous
Platanus orientalis	Oriental plane	Indigenous
Populus alba	White poplar	Indigenous
Populus nigra	Black poplar	Indigenous
Populus tremula	Common aspen	Indigenous
Prunus avium	Wild cherry	Indigenous
Pseudotsuga menziesii	Douglas-fir	Non-indigenous
Pyrus communis	Common pear	Indigenous
Quercus cerris	Turkey oak	Indigenous
Quercus frainetto	Hungarian oak	Indigenous
Quercus petraea	Sessile oak	Indigenous
Quercus pubescens	Downy oak	Indigenous
Quercus robur	Common oak	Indigenous
Quercus rubra	Northern red oak	Non-indigenous
Quercus suber	Cork oak	Non-indigenous
Robinia pseudoacacia	Black locust	Non-indigenous
Salix caprea	Goat willow	Indigenous
Sorbus torminalis	Wild service tree	Indigenous
Tilia cordata	Small-leaved lime	Indigenous
Tilia platyphyllos	Large-leaved lime	Indigenous
Tilia tomentosa	Silver lime	Indigenous
Ulmus glabra	Wych elm	Non-indigenous
Ulmus laevis	European white elm	Indigenous

Chapter 5 State of diversity within trees and other woody plants species

The assessment of the state of forest genetic resources is carried out during the inventory of all forests over a 10-year period. The research to assess the genetic variability of forest tree species was performed on 38 species (10 coniferous and 28 deciduous) with an emphasis on intraspecific variability, determining totally 449 varieties and forms (118 at coniferous and 331 at deciduous species). 37 ecotypes were evaluated and 57 provenance trials established, including 260 provenances and 29 progeny tests. Genetic analyzes through biochemical markers for 9 tree species were performed and through DNA markers - for 6 tree species.

The number of clones selected is 1445, while the number of clones used – 671, moreover with domination of coniferous species.

Table 4. Assessment of the state of genetic diversity

Botanic name of the species	**Morphological features**	**Ecotype**	**Provenance trials**	**progeny tets**	**Clone testing**	**Varieties and forms**	**Genetic markers**
Coniferous							
Pinus silvestris L.	√	√	√	√			√
Pinus nigra Arn.	√	√	√	√			√
Picea abies (L.) Karst.	√		√	√			
Abies alba Mill.	√	√	√	√			√
Pinus peuce Gris.	√		√	√			√
Pinus heldreichii Christ.	√						√
Pinus mugo Turra							√
Natural hibrids between *Pinus sylvestris L.* and *Pinus mugo* Turra	√			√			
Larix decidua Mill.and Larix kaempferi(Lamb.)Carr.			√				
Pseudotsuga menziesii (Mirb.) Franco			√				√
Broadleaf							
Acer campestre L.	√	√					
Acer platanoides L.	√						
Acer pseudoplatanus L.	√	√					
Acer hyrcanum Fisch. et	√						

May							
Acer heldrechii Orph. Ex Boiss	∨						
Betula pendula Roth.	∨	∨					∨
Castanea sativa Mill.	∨		∨	∨	∨		
Corylus colurna L.	∨						
Fagus sylvatica L.	∨	∨	∨				∨
Fraxinus excelsior L.	∨	∨	∨	∨			∨
Fraxinus oxycarpa Willd.	∨	∨					
Juglans regia L.						∨	
Paulownia sp. and their artificial nhybrids					∨		
Platanus orientalis L.	∨						
Quercus cerris L.	∨		∨				
Quercus frainetto Ten.	∨	∨					
Quercus petraea Liebl.	∨	∨	∨	∨			∨
Quercus thracica Stef.et Ned.				∨			
Quercus robur L.	∨	∨	∨	∨			∨
Quercus suber L.			∨				
Robinia pseudoacacia L.					∨		
Salix sp. And their artifical hybrids	∨				∨		
Tilia cordata Mill.	∨						
Tilia platyphyllos Scop.	∨						
Tilia tomentosa Moench.	∨	∨					
Populus sp. And their artifical hybrids	∨				∨		

In Bulgaria the activities for protection and sustainable use of forest genetic resources are carried out by the Executive Forest Agency, Forest Seed Control Stations-Sofia and Plovdiv, University of Forestry-Sofia and Forest Research Institute at the Bulgarian Academy of Science.

Monitoring of the state of forest genetic resources in the country shows that it is stable.

The above mentioned institutions have worked on 15 projects in the field of forest genetic resources. (Annex 1)

Numerous research projects on the intraspecific diversity of forest genetic resources have already been implemented in the country. Their distribution to different research organizations, partnerships with many national and European partners and the wide variety of often mixed funding make their follow-up a complex process. The country faces challenges, opportunities and needs related to increasing the availability of information on the genetic diversity of tree species.This involves investing in DNA molecular markers, identifying dynamic conservation units and follow-up monitoring. It is necessary to increase research for assessment of adaptive capacity of forest genetic resources to climate change, the development of climatic niches of populations and the potential loss of genetic diversity.

Establishing partnerships with Mediterranean countries related to the conservation, selection and transfer of genetic resources, as well as the management of the stands subject to severe changes in their climatic environment are of particular importance.

PART 3 STATE OF FOREST GENETIC RESOURCES CONSERVATION

Chapter 6 In situ conservation of forest genetic resources

The genetic resources of forest tree species are preserved in situ in the places of their natural distribution. An important contribution to the genetic conservation of forest tree species in situ have National parks - Rila, Pirin and Central Balkan with a total area of 193 000 ha and eleven Nature parks - Bulgarka, Vratchanski Balkan, Rila Monastery, Vitosha, Persina, Sinite Kamani, Strandzha, Shumen Plateau, Rusenski Lom, Zlatni pyasatsi and Belasitsa, with a total area of 256 441.4 ha and 90 reserves and maintained reserves.

All indigineous and other woody forest species conserved in situ include mainly the forest area of national parks, nature parks, reserves and seed production stands. Their share 11 % from the total forest cover in the country. The area of in situ preserved species on the territory of the country is 35599.6 ha, including 24 tree species, 8 of which are coniferous with an area of 22065.5 ha and 16 broadleaf species with an area of 13534.1 ha.

The main actors and stakeholders related to the conservation of forest genetic resources are: Forest Seed Control Stations - Sofia and Plovdiv, Executive Forest Agency, Forest Research Institute at the Bulgarian Academy of Science, University of Forestry and the Ministry of Environment and Water and its structures.

Forest tree and shrub species that are considered endangered in the country are: in the category of "high risk" - Quercus thracica Stef. Ned.; "Medium risk" - Castanea sativa Mill. and Eriolobus trilobata Roem.; "Low risk" - Aesculus hippocastanum L., Hippophae rhamnoides L., Taxus baccata L., Salix pentandata L.

According to the national legislation, for the long-term conservation of the forest genetic resources and dynamic genetic conservation, stands in forest territories, seed production stands in the forest seed production base and stands in protected areas are determined. The minimum size of plantations is determined depending on the tree species and conservation objectives, as follows:

- 500 or more regenerating trees (when the goal is to preserve the genetic diversity of widespread coniferous and broadleaf species);
- 50 regenerating trees (when the aim is to preserve adaptive or other characteristics in marginal or dispersed populations) or 50 seed-bearing trees (dispersed tree species with sexual dimorphism);
- 15 regenerating trees (when the aim is to preserve a population of rare or valuable tree species).

One or more target tree species, subject to genetic conservation are identified in each stand.

Maintaining forest genetic resources *in situ* faces many challenges:

- Natural disasters (storms, fires, biotic disturbances, etc.)
- Problems with natural regeneration
- Limited human and financial resources in relation to the identification of dynamic conservation units.

The priorities identified for improving the *in situ* conservation of forest genetic resources are as follows:

- Expand the national *in situ* conservation network by preserving specific local conservation units of native species.

- Defining operational indicators for monitoring of the conservation effectiveness of forest genetic resources: the revision of Forest Europe indicator 4.6 on the conservation and utilization of forest genetic resources, which allows standardization and coordination of data collection, calculation and reporting using standardized data from the EUFGIS information system of EUFORGEN, FOREMATIS (European Forest Reproductive Material Information System) of the European Commission Research Center (JRC) and GlobalTreeSearch (Tree Information System) and the Botanic Gardens Conservation International (BGCI. The revised indicator consists of four sub-indicators: Dynamic conservation (*in situ* and *ex situ*) of native species'populations; Dynamic conservation (*ex situ*) of populations of non-native species that have evolved locally; Static e*x situ* conservation; Forest reproductive material production. The first three sub-indicators relate to the protection of forest genetic resources. Quantitative criteria make it possible to assess conservation efforts, the genetic diversity involved in conservation, both interspecific and intraspecific, and the stability of the conservation network. The fourth sub-indicator concerns sustainable management. Quantitative criteria aim to assess the genetic diversity potentially available for utilization.

Chapter 7: Ex situ conservation of forest genetic resources

According to national legislation, the genetic resources of forest tree species are stored *ex situ* in:

1. Clonal collections, stool beds, seed production orchards, arboretums, geographical and other experimental plantations (Table 5);

2. Storage facilities for long-term storage of seeds and pollen.

For the gene bank in Forest Seed Control Station-Sofia, as a seed collection, lots of seeds from 12 tree species, and in Forest Seed Control Station -Plovdiv from 8 species are stored.

Table 5. Number and area of basic material for *ex situ* conservation of genetic resources

Type basic material / Tree species	Seed production orchards		Parents of family	Clonal collections		Stool beds /clones/	Total	
	number	area /ha/	number	number	area /ha/	number	number	area /ha/
Scots pine	5	14,4		2	6,6		7	21
Black pine	4	10,7					4	10,7
Macedonian pine	3	7,2		1	0,6		4	7,8
European silver fir	2	4,95					2	4,95
Atlas cedar	2	4,8					2	4,8
Locust	29	73,86					29	73,86
Cork oak	1	9,5					1	9,5
Silver lime	5	13,42		1	1,7		6	15,12
Small-leaved lime	2	1,74					2	1,74
Large-leaved lime	1	0,24					1	0,24
Blue spruce	1	2,2					1	2,2
Common oak	1	2,4					1	2,4
Poplars			41			35	76	0
Turkish hazel						4	4	0

According to Art. 2 of the Convention on Biological Diversity the *ex situ* conservation of genetic resources is defined as "the conservation of components of biological diversity outside their natural habitats." *Ex situ* collections include whole plant collections, zygotes, gametes and somatic cells. There are fundamental differences between whole plant collections, such as seed orchards, and collections such as cryopreserved seeds or embryos. It is advisable to maintain a dynamic situation in which natural processes take place, such as gene flow and natural selection. Static *ex situ* measures are those that, instead of promoting a dynamic situation, keep the material stagnant - such as cryopreservation of tissues.

In order to optimize conservation efforts, it is necessary to prioritize species and to coordinate conservation measures at European level. Prioritization of species must take into account: the need for conservation according to the importance of the species, the urgency of conservation according to the species and the intensity of the threat, as well as the feasibility according to the expected costs and impact of the available measures.

Ex situ conservation measures are often closely linked to the urgency of the action. Knowledge of (potentially) endangered tree species and populations would allow for earlier intervention for *ex situ* conservation.

The best practice in seed collection is to meet the minimum requirements relating to: population size, number of mother trees, maximum spatial and ecological distance of mother trees and number of years of production of forest reproductive material from of the stand.

The presence of a large number of regenerating individuals is crucial to ensure the best opportunity for natural selection processes. If possible, *ex situ* conservation units should be established with at least 5 000 saplings collected from populations containing at least 500 adult individuals. *Ex situ* conservation stands must be created from seeds collected in at least two seasons from at least 50 spatially separated mother trees, growing within the ecological conditions within the stand. (Skrøppa, 2005). For scattered, rare and endangered species that have populations with a small number of trees, the minimum numbers need to be reduced. Alternatively, the association of fragmented subpopulations with neighboring subpopulations in *ex situ* conservation units may be allowed in order to achieve minimum viable population thresholds.

Dynamic *ex situ* conservation involves the establishment of populations outside their natural habitats with an emphasis on supporting and sustaining natural regeneration in the population. In some cases, it will not be possible to maintain populations at their current location, so assisted migration may be the only option for dynamic conservation (Thomas, 2011). Assisted migration can be carried out by foresters, by introducing origin or species in a new area or by supporting natural migration.

Assisted migration is seen by some authors as a potentially important strategy for adapting to climate change (Millar et al., 2007; Campbell et al., 2009), but should only be seen as an additional measure or as a last measure, as information for effects on most tree species is still lacking. (Eskelin et al., 2011).

In order to minimize the unforeseeable consequences, the establishment of *ex situ* conservation units resulting from assisted migration should be carried out gradually over relatively short geographical and environmental distances. These distances should not exceed the maximum threshold equivalent to the expected change over the next 20-30 years, or within 25% of a rotation (eg O'Neill, 2013; Wang et al., 2010a and 2010b).

It is recommended to create at least two *ex situ* units for each valuable conservation unit, as the greatest efforts are in the collection and cultivation of reproductive material and the risk of losing one

population can be high. Once the unit is duplicated, the natural processes still take place in the original unit and they must be protected and monitored.

For some tree species, the preferred approach of dynamic conservation will not be possible and in these cases the only alternative is to keep the species static in a seed bank or gene bank (e.g. cryopreservation). In general, the earlier the intervention, the more effective it is and in most cases it is also the more cost-effective. In parallel with the preservation of individuality statically, other static measures must be taken for *ex situ* conservation, such as the preservation of individuals in botanical gardens, artificial populations in seed orchards and genotypic collections.

The main institutions responsible for ex situ conservation are the Forest Seed Control Stations - Sofia and Plovdiv, Executive Forest Agency, FOREST Research Institute at the Bulgarian Academy of Science and the University of Forestry.

Ex situ storage of forest genetic resources faces many challenges:

- Limited knowledge of genetic diversity for the creation of *ex situ* collections.
- The rapid aging of the collections of forest reproductive material that require annual maintenance and renewal.
- The scarcity of human and financial resources has a negative impact on research and creation of collections that require lengthy work, sometimes requiring decades of research, to gather a representative sample of the genetic diversity of species and to maintain collections that require annual maintenance.

The priorities identified for improving the *ex situ* conservation of the forest genetic resources are as follows:

- Characterization of existing collections.
- Identify species and populations vulnerable to climate change to ensure their conservation.
- Increase research and efforts for more sustainable conservation methods (cryopreservation of buds, seed gene bank, genetic analysis).

PART 4 STATE OF USE, DEVELOPMENT AND MANAGEMENT OF FOREST GENETIC RESOURCES

Chapter 8 The state of use of forest genetic resources

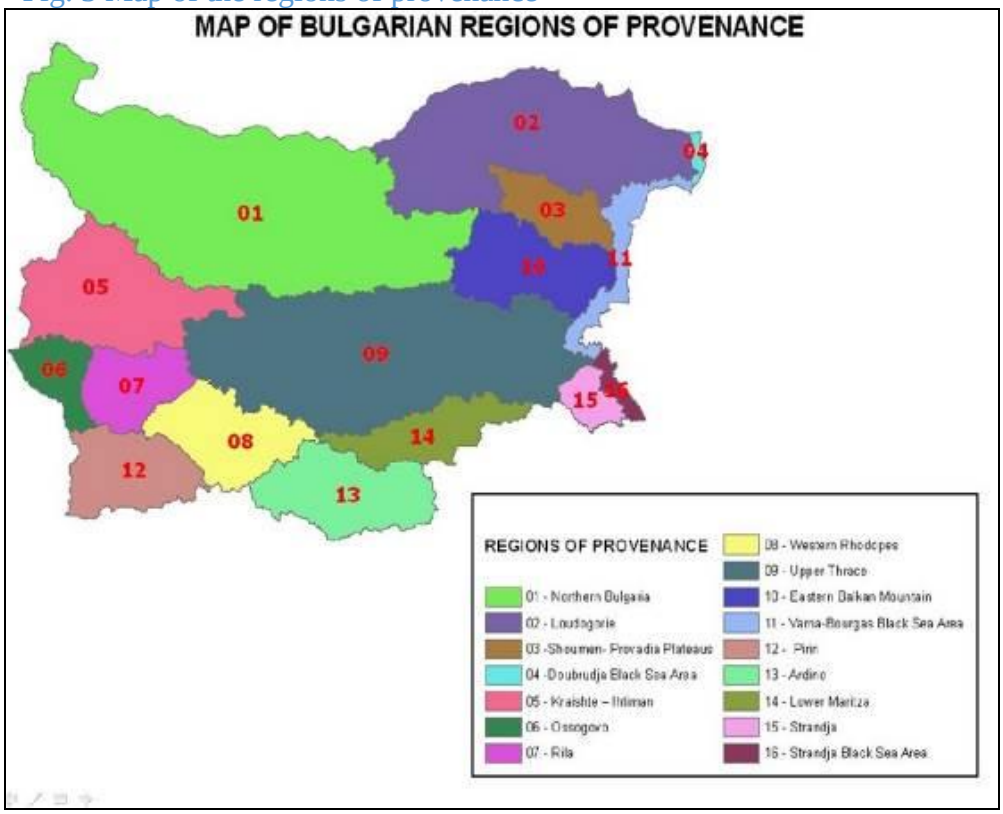
Forest genetic resources represent the entire genetic heritage of forests and are a key tool for adapting species to current and future climatic conditions. FGR are renewed by natural regeneration or by the use of forest reproductive materials (FRM), appropriately selected for afforestation. This renewal aims to ensure the sustainability of forests today threatened by the effects of climate change, while ensuring their productivity.

At the international level, the Organization for Economic Cooperation and Development (OECD) scheme for the certification of forest reproductive material intended for international trade sets out the rules for the certification of FRMs to facilitate their exchange between and within EU Member States, as well as in other OECD member countries: North America, Turkey, Norway, Switzerland, Serbia and several African countries. Bulgaria has been a member of the OECD Scheme since 2018.

At European level, the use of FRMs is regulated by Council Directive 1999/105/EC on the marketing of forest reproductive material, in force since 2003. According to the Directive, the tree species listed in Annex № 1 are allowed for marketing if they comply with its provisions. The aim is to provide a regulatory chain of traceability, guaranteeing the origin of forest reproductive materials offered for forestry purposes during afforestation, but also to provide information on the genetic and phenotypic qualities of these FRMs.

The region of provenance for a species is defined in the Council Directive 1999/105/EC as “the area or group of areas subject to sufficiently uniform ecological conditions in which stands or seed sources showing similar phenotypic or genetic characters are found, taking into account altitudinal boundaries where appropriate”. In Bulgaria, 16 regions of provenance have been identified (Fig. 3). Each region of provenance is marked with an official name and a six-character code defined in Ordinance № 21/12.11.2012 (e.g. AAL007 - Abies alba, Silver fir, Rila).

Fig. 3 Map of the regions of provenance



The Executive Forest Agency, together with the Forest Seed Control Stations, regularly updates the Register of approved basic material for the production of forest reproductive materials (seed source, stands, seed orchards, clones, clonal collections and stool beds) used for marketing (seeds, seedlings, cuttings, etc.). In accordance with the Council Directive 1999/105/EC, the approved basic material are of four categories – “Source-identified”, “Selected”, “Qualified” and “Tested”. In Bulgaria there are no registered ones in the category "Tested".

In Annex № 2 the data on the distribution of stands for seed production by tree species and regions of provenance are presented. These data serve for planning of further actions for the development of the system for protection of forest genetic resources, by optimizing the forest seed production base depending on the available basic material and the need to include new ones, based on the FRMs needs for forestry practice.

Depending on the country for which the FRMs are intended, the requirements for certification of EU member states - Council Directive 1999/105/EC, and for the third countries - the requirements of the OECD, are strictly observed. The FRMS marketing is carried out by registered suppliers. Upon extraction of FRMs, a master certificate of identification is issued, the lots are accompanied by a copy of the certificate, a label and a delivery note.

174 forest nurseries are registered on the territory of the country, 152 of which are state property. The total area of the nurseries is 1495.9 ha.

Table 6 Quantities of collected seeds and produced seedlings for afforestation

Type of activity	**2017**	**2018**	**2019**
Collected seeds, kg	56171	43732	33076
Produced seedlings	11537000	11593600	10506600

Chapter 9 The state of genetic improvement and breeding programmes

Seed production orchards are one of the tools of selection to increase the productivity and sustainability of forests. So far, 60 seed production orchards (generative and vegetative) of 14 tree species have been established in Bulgaria.

Similar to the history in other countries, in Bulgaria the selection activity begins with the testing of different provenances of the tree species under certain ecological conditions, or the so-called common gardens - Scots pine (in Yundola in 1959 and elsewhere later), Spruce (in Govedartsi and other places), and later Black pine and Fir. These experiments represent the oldest form of selection studies of the tree species in our country.

In the 1960s and 1970s, various programs for the selection of tree species began to be implemented.

The achievements of analytical selection can be summarized as follows:

- The nature of the variability of the most important tree species in Bulgaria has been established. For example, in most coniferous species discontinuous variation is found, while in Norway spruce continuous variation is found.
- The phenotypic variability of a large number of species in Bulgaria has been established. Forms are defined and described by various features, both diagnostic (i.e., related to a business value) and non-diagnostic, i.e. not carrying information on economically valuable features.
- A large number of seed production stands and plus trees have been selected. These results have been achieved in the joint work of scientists from Forestry University, Forest Research Intitute, experts from the two Seed Control Stations and the activity is coordinated by the forest setvices.

Using active selection, experimental objects of the following types were created:

- Common gardens - testing the reaction of different provenances to certain ecological conditions; in the country 67 “geographical plantations” have been created - 40 of coniferous and 27 of broadleaf tree species, which include 354 provenances (173 coniferous and 181 broadleaf tree species);
- Heritability experiments - breeding of half-sib progenies (from free pollination) of different species, mainly coniferous;
- Seed orchards - generative and vegetative, mainly of coniferous species – Scots pine, Silver fir and Black pine. Many Sctots pine seed orchards were established in 70s, three of them according to ecotype - low, medium and high-mountain ecotype of the species.
- Clonal collections
- Artificial hybridization - carried out mainly by poplars. Controlled hybridization was performed in other genera and species;

The goals of the improvement of the tree species are related to the increase of:

- Adaptability to different environmental conditions and, accordingly, survival;
- Growth and productivity in height, diameter and volume;
- The quality of the stems (this complex indicator includes stem straightness, stem taper, self pruning, etc.);
- Resistance to diseases and pests;

The aim is to implement the combined selection, i.e. the improvement of one valuable trait should not be at the expense of the others, but to achieve improvement in all traits. The aim is to provide sowing and planting materials with improved heredity qualities.

For the most species, improvement measures are related to the conservation of genetic resources *ex situ.* Many objects with primary purpose related to selection (seed orchards, clonal collections) are simultaneously used to protect genetic resources.

The main stakeholders in the programs for the improvement of the tree species are the University of Forestry, Forest Reasearch Institute at the Bulgarian Academy of Science, Forest Seed Control Stations and Executive Forest Agency.

In the improvement of tree species in Bulgaria there is a desire to introduce new research and applied methods that could accelerate the process of improvement. Among the most important of these may be biotechnological methods for the reproduction of valuable genotypes, such as in vitro cloning and somatic embryogenesis.

Common gardens are a valuable genetic resource, especially in the context of a changing climate. The maintenance and conservation of them require greater responsibility from the governmental and scientific institutions. There is a potential for expanding the system of common gardens, administrative and scientific capacity for their study, as well as for research on variability in existing populations. Common gardens are and will be the basis for zoning of the seed use, taking into account the preservation of existing biodiversity and preventing genetic contamination of local populations.

The perspectives of seed orchards should be considered in the light of the volumes of future afforestation. Vegetative seed orchards of the second cycle of selection can serve as a very effective tool for increasing the productivity of fast-growing plantations. It is necessary to reassess the importance and perspectives of the numerous seed orchards created in the framework of the distribution of Sctos and Black pine, as the rich experience with Abies alba can be used by other species.

Chapter 10 Management of forest genetic resources

In the management of genetic resources, the main goal is to ensure abundant regeneration and a rich genetic fund. For basic species, the management does not differ significantly from the normal silvicultural practices used in Bulgaria. The most important aspect is to support natural regeneration. Special attention is paid to the creation and maintenance of an approximately even distribution of the different age classes. Usually a stand of a certain tree species is chosen for genetic conservation, but in some cases one unit can be used for the conservation of two tree species. The total number of genetic conservation units in Bulgaria is 6, with a total area of 29.7 ha.

Forest management includes the management of forest genetic resources. Although the care for their protection, as part of the silvicultural activity, includes their management. The purposeful management of the FGRs in Bulgaria officially began in 1952, when the foundations of this activity were laid and the two Seed Control Stations were established. Their primary task is to select permanent stands for seed production. The activity related to the management of FGRs is defined in the instructions issued then and later.

In order to assess the potential of forest genetic resources, it is necessary to increase research on the intraspecific diversity of tree species, to follow the principles of *in situ* and *ex situ* conservation and to deepen knowledge of the ecology of forest tree species. In the future, it is necessary to build research

and development partnerships related to the conservation, selection and transfer of genetic resources in relation to changing climate.
Due to the uncertainty regarding climate change, it is necessary to maintain the maximum capacity of forest ecosystems to adapt.

Needs, challenges and opportunities

- Introduction of practices for sustainable management in natural forests, leading to *in situ* conservation of FGRs;
- Use of protected areas for protection of FGRs;
- Determination of dynamic conservation units for protection of FGRs;
- Detailed inventory of forest genetic resources in our country;
- Application of genetic markers to establish genetic diversity in relation to zoning of seed use
- Strengthen international cooperation in the field of management and conservation of FGRs. In this regard, it would be a positive moment for Bulgaria to reconsider its withdrawal from the International Program for the Conservation of Forest Genetic Resources (EUFORGEN);
- Elaboration of a strategy for managing FGRs in relation to changing climate.

In recent years, problems have arisen in coniferous monocultures. These problems are related to various reasons: climate change, unsuitable origins, untimely thinnings and, as a consequence, bark beetle attacks, damage by abiotic factors (windfalls, windthrows, snowfall and snowthrows). This can lead to significant damage to some of the monocultures and as a result to the need for a new wave of afforestation and, accordingly - from seeds and planting materials with improved hereditary qualities.

Priorities for capacity building and research in this area

- Inventory and activation of the created sites from the seed production base, for which there is currently insufficient information and which are insufficiently used;

- Research in relation to the management of genetic resources in the light of climate change;

- Creation of seed orchards from broadleaf species - there are created only from: Black locust (Robinia pseudoacacia), lindens (Tilia), Common oak (Quercus robur) and Cork oak (Quercus suber).

PART 5 STATE OF CAPACITIES AND POLICES

Chapter 11 Institutional framework for the conservation, use and development of forest genetic resources

The institutions actively engaged in forest genetic resources are:

- Ministry of Environment and Water and Executive Forest Agency of the Ministry of Agriculture. They conduct the state policy in the field of forest genetic resources, as its main aspects are related to legislative initiative - preparation of regulations and regulatory and control functions.
- Forest Seed Control Station - Sofia and Forest Seed Control Station - Plovdiv control and coordinate the implementation of legislation in the field of forest reproductive materials, create and maintain seed collections for conservation of forest genetic resources.
- Forest Research Institute, BAS - conducts scientific and applied research of forest ecosystems, creates the theoretical and scientific basis for practical solutions in connection with forestry management systems, forest genetic resources, forest protection, erosion and flood control, and supporting the forest and nature protection policy process and legislation.
- The University of Forestry is a research center for basic and applied research, covering all aspects of sustainable use of biological resources.

There is no separate strategy for forest genetic resources in Bulgaria. At a meeting of the Council of Ministers on 27.11.2013, the National Strategy for Development of the Forestry Sector in the Republic of Bulgaria (NSDFSRB) for the period 2013-2020 was adopted. One of its priorities is "Conservation, restoration and maintenance of biological and landscape diversity in forest areas". Measure 2.3 for implementation of the priorities is: "Maintenance and development of the system for conservation of forest genetic resources"

Based on the goals, priorities and measures set in the NSDFSRB 2013-2020, the Strategic Plan for Development of the Forest Sector 2014-2023 has been prepared, which defines the specific activities for their implementation. Activities related to forest genetic resources are set out in Operational Objective 7, namely:

7.1 Preservation of genetic diversity and the construction of a system of actions for the protection of the local genfond by the method "ex sito".

7.2 Expansion and maintenance of the forest seed production base.

7.3 Production of the necessary seeds for the formation of the seed collections of the most valuable tree species for the conservation of forest genetic resources.

7.4 Establishing the seed orchards of rare, valuable and dry resistant tree species and bushes in order to protect them and ensure the reproductive material of them.

7.5 The genetic evaluation of the basic material of the forest seed productive base and preservation of valuable genetic fund.

The management and conservation of forest genetic resources are represented in the Forest Act (2011); Protected Areas Act (2002) and Biodiversity Act (2002). According to the provisions of the Forest Act, Ordinance № 21 of 11.12.2012 on the terms and conditions for determination, approval,

registration and cancellation of the sources of forest seed production base, collection and extraction of forest reproductive material, their qualification, marketing and import has been adopted.

The state of research of forest genetic resources is described in Chapter 5 State of diversity within trees and other woody plants species

The institutional framework for the conservation of forest genetic resources, related legislation and regulations, the implemented public policies and their main objectives are discussed in Part 3 State of forest genetic resources conservation

The institutional framework for the use and development of forest genetic resources, related laws and regulations, implemented public policies and their main objectives are discussed in Part 4 State of use, development and management of forest genetic resources.

Regarding the level of training and education of forestry professionals, it is carried out by disseminating information on the results of research on forest genetic resources to stakeholders. In addition to the transfer of knowledge, methods and tools for forest management, consultations between public institutions and forest owners, and the joint development of national forest policies are key elements of effective multifunctional sustainable management and the development of strategies for adapting forests to climate change.

Chapter 12 International and regional cooperation on forest genetic resources

This report was prepared in the framework of the Global Plan of Action for the Conservation, Sustainable Use and Development of Forest Genetic Resources, FAO.

Bulgaria's policy on forest genetic resources is in line with the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity

Regarding the conservation of forest genetic resources, Bulgaria participates in the European Forest Genetic Resources Programme EUFORGEN until 2014. In the context of accelerating climate change, continuing work on the conservation of forest genetic resources is a priority. The international continuity of plant species areals also requires the development of a conservation strategy at European level in addition to national strategies in order to define appropriate and complementary conservation units for continental conservation.

The cooperation is also realized through international research projects, connecting Bulgarian organizations for research and development of forestry with other European organizations, in order to pool resources, share resources and exchange of experience.

Regrading the use of FGRs, international trade is governed by European regulations (Council Directive № 1999/105/EC and OECD) (see Chapter 8).

PART 6 CHALLENGES AND OPPORTUNITIES

Chapter 13 Recommended actions for the future

The challenges and opportunities in the field of forest genetic resources we currently face and the resulting objectives are described in Chapter 5, Part 3, Part 4 and Chapter 10.

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