

# Good Silver Fir (*Abies alba Mill.*) Resources in Kosovo and their Conversion in to Seed Stands

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**Abstract** – The silver fir is a tree growing in western, central and southern Europe. In France, it is found at mountain heights (900 to 2000 m), but in southern Europe only in the mountains. The silver fir is one the largest of European trees, reaching heights of more than 60 m in virgin forests and living for five hundred years. The European silver grows well in shade when young, but requires moist soil and clean air, and is susceptible to severe winter frosts. Silver fir (*Abies alba Mill.*), an ecologically significant tree species native to many European mountain forests, is currently one of the most economically important conifers in Kosovo. It is one of the tallest trees growing on the mountain regions of the country. A UN-FAO financed project to support the implementation of Forest Policy and Strategy in Kosovo adopted in 2010. According to this project from now to the year 2026, Kosovo must plant about 32,000 ha of forest with native tree species such as: beech (*F. sylvatica L.*), oaks (*Quercus sp. L.*), spruce (*P. abies Karst.*), fir (*A. alba Mill.*), pine (*P. nigra & P. sylvestris*). Seed requirement for this plan-ting plan in Kosovo is very great. Present capability of seed supply of the mentioned species from seed stands can't meet the requirement. To overcome this situation it was immediate establishment of seed stands. Stand selection involves the consideration of a complex of factors and represents one of the most critical stages in seed stand establishment. For this a questionnaire was undertaken with relevant institutions like Kosovo Forest Agency, Forestry Institute, private forest owners and municipalities to get the information on possible locations which can be used as seed source collection. In the end 2 stands were selected with an area of 5 ha and necessary data were collected in the field.

**Keywords** – Silver Fir, Seed Stands Establishment, Provenance, Tree Improvement, Seed Orchards.

## I. INTRODUCTION

According to forest inventory in Kosovo shows those forests, forest lands and wastelands in Kosovo covering a total of 512,400 ha (46.83%). From this total area 460.800 ha (89.3%) are forests, 28.200 ha (5.50%) are forest lands and 23.400 ha (4.57%) are wastelands. Approximately 44.7% (481,000 ha) of Kosovo's area is under forest cover [21] and the need to assess, manage and develop this forestry estate to create both employment and investment opportunity is paramount. In Kosovo, natural silver fir forests comprise pure forests and forests mixed with other conifers, such as black pine (*Pinus nigra Arn.*) or broadleaf trees such as beech (*Fagus sylvatica L.*) and maple (*Acer pseudoplatanus L.*).

Despite high levels of intra-population genetic variation, increased use of the forests, climate change and disease outbreaks undoubtedly affect the species' resources and requires intensified genetic conservation. Silver fir shows the highest average annual increment among forest trees

(2.7 m<sup>3</sup>/ha) compared with other economically important trees as beech (2.34 m<sup>3</sup>/ha) or black pine (1.58 m<sup>3</sup>/ha).

Table 1: Stand volume of main wood-species in Kosovo (dbh > 7 cm) in 1000 m<sup>3</sup> [15]

Nr	Wood-species	2002	2012
1	<i>Quercus cerris</i>	5.170	4.282
2	<i>Quercus petraea</i>	4.276	3.669
3	Other <i>Quercus spp.</i>	129	1.292
4	<i>Fagus spp.</i>	15.963	18.524
5	Other broadleaves <i>spp.</i>	3.704	6.750
6	Unidentified broadleaves	5.983	0
7	<i>Abies alba Mill.</i>	1.577	1.573



Fig. 1. Distribution of silver fir in Europe [6].

The altitudinal distribution varies greatly throughout the range. Silver fir attains its best development in areas where there is comparatively high humidity, cold temperatures and high rainfall. A sheltered situation is adequate for its development. The major factor shaping its distribution is the amount of annual rainfall (1000-2100 mm). The tree can grow on different bedrocks from magmatic to *ultrabasic formations*. Silver fir can achieve its optimum growth in soils derived from limestone or dolomite lime-stone. In areas where fir is associated with beech (*Fagus sylvatica*), the soil pH is acid to neutral, while in its associations with black pine (*Pinus nigra*), oak (*Quercus spp*) and maple (*Acer pseudoplatanus*) soil acidity ranges from 6.7 to 7.7 [4].

### 1.1. Conservation

*Abies alba* has an extensive natural range and shows considerable morphological and physiological variation especially in its southern limit [5]. In Kosovo several populations are severely threatened by increased harvesting; forest fragmentation, climate change and insect and disease outbreaks. These threats highlight the urgent need for conservation and sustainable management of fir resources, and protection of appropriate amounts of genetic variability. Developing science-based conservation strate-

gies and maintaining minimum viable populations will represent other important challenges towards the conservation of Kosovo fir genetic resources. Parts of the Kosovo territory have designated as protected areas and will play an important role in "in situ" conservation.

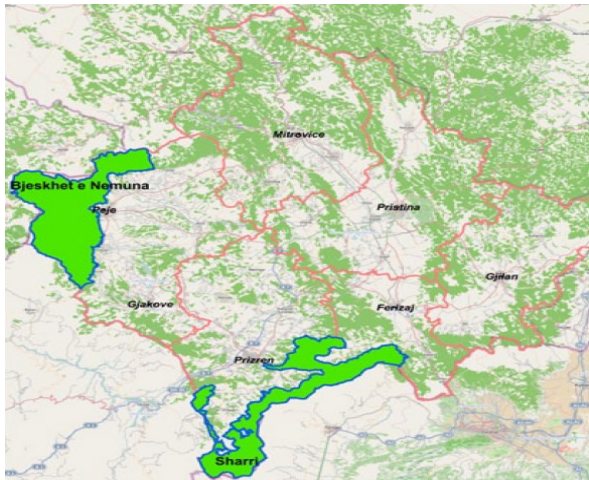


Fig. 2. Location Protected Areas (Sharri NP) and Deçan Forest Landscape in Kosovo [23]

*In situ* conservation of forest genetic resources has, for several years, been attracting more attention throughout almost all the countries of the Europe. Extensive forest areas are now placed under various regulations aimed at the conservation of natural resources. The main protected areas include: national or regional parks, nature reserves, biosphere reserves & biogenetic reserves.

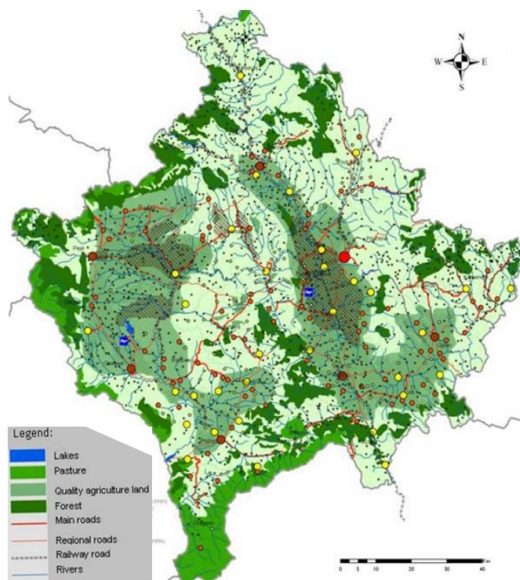


Fig. 3. Map of forest cover of Kosovo [23]

The degree of protection depends upon the scope and the objectives of the programme. Depending on the scope of protection, local conditions, country regulations, management and harvest can be completely excluded or subject to special rules or limitations. Unique examples of *in situ* conservation areas are forest stands set aside for seed collection.

## II. MATERIALS AND METHODS

The choice of seed source may be decisive for the success or failure of plantings. To facilitate the choice of seed source for meeting the requirements it will be useful if publications are available on the location of seed sources and criteria for selection of the seed sources.

The following categories of seed sources for collection of seed were defined and classified: seed collection zones, identified and selected stands, seed production areas, provenance seed stands. A seed source must consist of trees of such an age and development that criteria for selection can be clearly judged. A seed source must also consist of well distributed numerous trees on a given area making possible adequate inter-pollination as to avoid increased risk of future inbreeding. Selection criteria were limited to a few phenotypic important traits estimated to have a relatively high heritability.

The location of the seed sources of fir (*Abies alba* Mill.), were described and the boundaries of the sources were identified and demarcated in the field. A selected stand is a stand of trees superior to the accepted mean for the prevailing ecological conditions when judged by the selection criteria [15]-[16] on the information collected at the regional offices of the Kosovo Forest Agency, based on questionnaires sent to the following offices, we organized on-site inspections of candidate stands to be selected for collection of seeds as planting material for future afforestations in Kosovo.

### 2.1. Objectives of the Study

The study was conducted in Deçani and Shari National Park. Mean annual precipitation is 1,140 mm with the mean July temperature of 15.5 °C. The main criterion for choosing the study area was the presence of natural silver fir regeneration. The stands were situated at an elevation of 500-700 m in the lower mountain forest zone. The investigated stands grow on wet, deep and rich brown acid soils, frequently not far from streams in the *Luzulo-Fagetum* community [3]. The age of the stands was different and ranged from 90 to 170 years.

Nowadays they are partly a protected reserve where some treatments are done, especially sanitary cuts. In each stand data on stand structure were collected in circular plots. Each circular sample plot consisted of areas 100 m<sup>2</sup>. The following measurements of natural fir regeneration were conducted: height, diameter, vitality and age. Survey and selection of good forest stands for their conversion into seed stands. The first step taken in delineation was to produce an accurate map of the distribution of silver fir seed sources in Kosovo.

It was important to select stands in which there is likely to be a significant genetic component in the phenotypic superiority. The second step was to determine the original, large scale populations that were present. These main populations were then examined for lesser discontinuities resulting from soil types, mountain ridges and human interference.

The stands must consist of trees well distributed and sufficiently numerous to make possible adequate inter-pollination. The stands must be of such an age and

development that adaptability and the criteria for selection can be clearly judged. Stands which are too young for seed bearing should be kept on record as candidate stands. Selection criteria should be limited to a few important traits. In many countries in the temperate zone the following minimum requirements used by the OECD Scheme for the Control of Forest Reproductive Material [15] are recognized:

## 2.2. Selected Stands

### Definition:

A selected stand is a stand of trees superior to the accepted mean for the prevailing ecological conditions when judged by the selection criteria [15]. The stands are selected because of their phenotypic superiority in specified important traits. It is important to select stands in which there is likely to be a significant genetic component in the phenotypic superiority for instance, a stand should not be selected solely because it is growing well on an exceptionally good site.

Selection criteria were limited to a few important traits. In many countries of temperate zone the following minimum requirements used by the OECD Scheme for the Control of Forest Reproductive Material are recognized:

### 1. Uniformity:

The stands must show normal degree of individual variation in morphological characters.

### 2. Volume Production:

Volume production of wood is normally an essential criterion for acceptance of selected stands. Volume production of wood must normally be superior to the accepted mean.

### 3. Wood Quality:

Shall be taken into account and in some cases, may become essential criterion.

### 4. Form & Growth Habit:

The trees in selected stands must show particularly good morphological features, especially straightness and circularity of stem, small size branches and good natural pruning. The proportion of forked trees and with spiral grain should be low.

### 5. Health and Resistance:

The trees in selected stands must in general be free from attack by damaging organisms and show resistance to adverse conditions of climate and site in the place.

### 6. Geographic History:

The location of seed source must be described and the boundaries must be easily identifiable in the field, where necessary by demarcation. As regards origin, it must be carefully checked whether the stands are of local origin or introduced. Very often the information on origin is lacking.

### 7. Genetic History:

Must be carefully checked.

### 2.3. Selection of Plus Trees

Plus trees are used [13] for: (1) the establishment of seed orchards, (2) direct silvicultural purposes, if a clonal propagation by means of cuttings is possible, (3) use in hybridization, i.e. in tree breeding work. In this report we are going to treat a number of problems and individual views about plus tree selection. The selection of plus trees

should be carried out in seed production areas where previously an inventory was made. Besides other characters, a plus tree should surpass in diameter b.h. the stand mean tree by over 1.1. Requiring and practising intense selection is easier if we are concerned with characters which can be measured, rather than with those which are expressed in a descriptive manner.

SCHREINER [13] recommends that selection be restricted to those trees which exceed the mean by two or three. ANDERSON [1]-[2] states that selection of plus trees has been performed so far on the basis of a relative estimate of the growth rate, stem form, saw-timber grade, wood quality, seed production and resistance (Tab. 2). Selection of plus trees will be much more successful if it is made for one or two characters. **Moreover, it is very difficult to find a tree which is excellent in many characters.** It is also very important to know the range of variability of characters to which we pay special attention in the selection of plus trees. According to MITCHELL [7], the most important properties are: density, ratio between early wood and latewood within the growth ring, number of growth rings per cm, fibre length and fibril orientation.

Table 2. Characteristics of the trees to being selected as plus trees.

a) Crown form	Number	%	b) Height of the crown	Number	%	c) Branching					
						down		up			
Coniferous	93	100		93	100	Category	Number	%	Number	%	
Conical	19	20	1/2 of Height	05	10	< 60	05	10	18	20	
Symmetric	74	80	1/3 of Height	16	15	60-90	18	20	18	20	
Flag			1/4 of Height	68	75	>90	66	70	57	60	
d) Type of branching	Number	%	e) Full wood	Number	%	f) Right of the trunk		Number		%	
Brushed	19	20	Weak	00	00			05		05	
Brush	09	10	Good	28	30			14		15	
Flat	65	70	Very good	66	60			56		60	
Indifferent	00	00	Great	09	10			18		20	
g) Trunk quality (Bifurcation)	Number	%	h) Branch diameter	Number	%	i) Number of branches in annual circles (for years of age)					
Low	00	00	Very large	05	05	4				55	70
On average high	09	10	Big	05	05	5				18	20
High	5	05	Medium	09	10	6				09	10
Does not exist	79	85	Thin	74	80	7				00	00
j) The distance between the annual down	Number	%	k) cleanliness of trees trunk	Number	%	l) Damages					
				93	100						
0.2 m	09	10	Weak	09	10	Strong				00	00
0.4 m	18	20	Good	28	30	Medium				00	00
0.6 m	19	20	Very good	47	50	Weak				19	20
0.8 m	47	50	Great	09	10	Does not exist				74	80
m) Infections from disease and insects	Number	%	n) Twisted trunk	Number	%	o) Rude bark finish					
	93	100		93	100						
Strong	00	00	Strong	00	00	High				09	10
Medium	00	00	Medium	00	00	Highly average				19	20
Weak	05	05	Weak	09	10	Low				65	70
Does not exist	88	95	Does not exist	84	90						
p) The structure of the bark	Number	%	q) The color of the bark	Number	%	r) Productivity					
	93	100		93	100						
Very cracked	00	00	Brownish-Reddish	00	00	Weak				09	10
Cracked	09	10	Gray easy	65	70	Good				18	20
With yarn	18	20	Dark gray	28	30	Very good				65	70
Smooth	65	70									

## III. RESULTS

During recent years seedling production has been based on sowing seeds imported from abroad. Afforestation projects that have used these seedlings have often suffered from high levels of plant mortality, that can be attributed to a combination of factors which include:

- Incorrect species selection in that the selected species is not compatible with local ecological conditions within the afforestation area.
- Lack of maintenance within the afforestation area post planting.
- Poor quality seed which was initially used to produce the seedlings.

For this reason we undertook this study and its aim was to select native silver fir seed stands within Kosovo which have a defined, known phenotype and genotype and where

the stand could be classed as being of “high quality”. Taking into account the above criteria, it became a site inspection of some forest stands, checking with a test to look at the conditions of the forest stands.

Stands who did not fulfill one of the above criteria, were excluded from the list of candidates for seed stands. Stands who fulfilled these criteria at first glance, was accepted, but of course, there will be other measurements and observations, to make a final selection of seed stands. Below we give brief information on the inspected piles, providing the end of each description of the opinion, if accepted as seed stand. The selected seeds stands, are presented in the following tables 3 and 4.

Table 3. Selected Seed Stands of silver fir in Kosovo

Nr	Management Unit	Plot Nr.	Species	Area plot Ha	Area of seed stand
1	Bredhik	33/1	<i>Abies alba</i> L.	37.86	6.10
3	Bogaj	32/1	<i>Abies alba</i> L.	23.59	5.50
5	Deçan	57/2	<i>Abies alba</i> L.	36.80	6.80

Table 4. Key Dendrometric characteristics of the seed stands

Key Dendrometric characteristics	Bredhik <i>Abies alba</i> Mill	Bogaj <i>Abies alba</i> Mill	Deçan <i>Abies alba</i> Mill
Average diameter (cm)	41.7	34.1	44.8
Average height (m)	32.0	26.0	29.9
Trees number per ha	453	495	679
Basimetric area (m <sup>2</sup> /ha)	61.9	49.7	106.8
Stand volumme (m <sup>3</sup> /ha)	774	648	507
Age (years)	97	90	105

### 3.1. Mein Dendrometric Characteristics of Selected Seed Stands

#### 1. Seed Stand nr. 1 Bredhik (*Abies alba* Mill.)

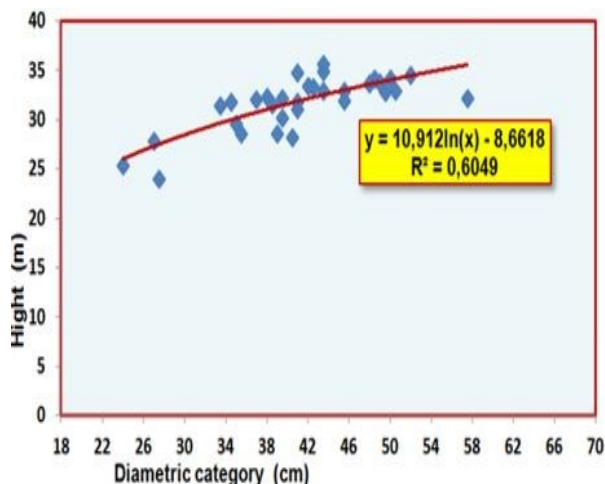


Fig. 4. Correlation between height and diameter in the forest stand Bredhik - Plot Nr. 101

Table 5. The distribution of trees by diametric categories in FS Bredhik Plot Nr. 101.

Diametric category	Trees number/ha	Basimetric area m <sup>2</sup> /ha	The average size of tress		
			g <sub>mes</sub>	d <sub>g</sub>	h <sub>g</sub>
22	14	0.54			
26	28	1.50			
30	0	0.00			
34	57	5.14			
38	85	9.62	0.137	41.7	32.0
42	127	17.63			
46	42	7.05			
50	85	16.66			
54	0	0.00			
58	14	3.74			
	453	61.88			

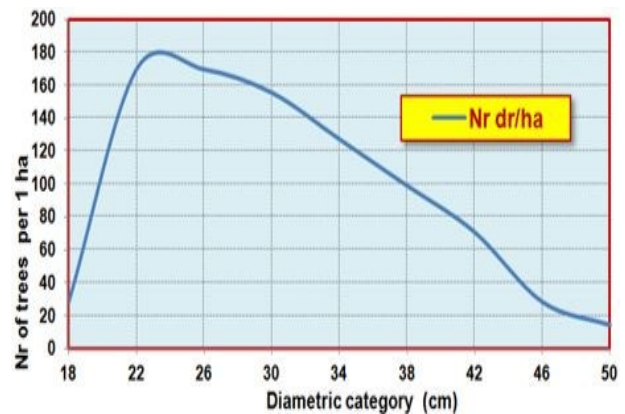


Fig. 5. The structure curve in relation to the diameter in the forest stand Bredhik - Plot Nr. 101

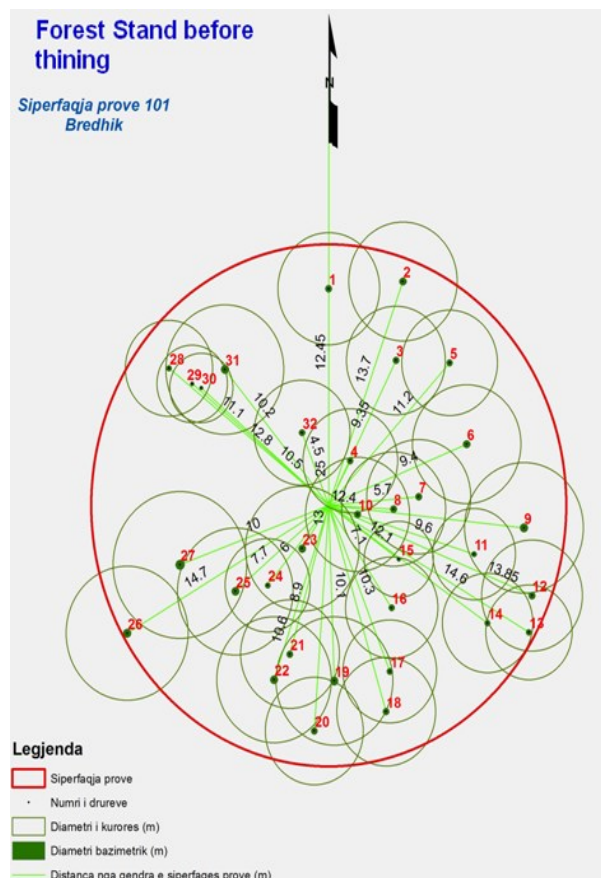


Fig. 6. Forest Stand structure before thinning

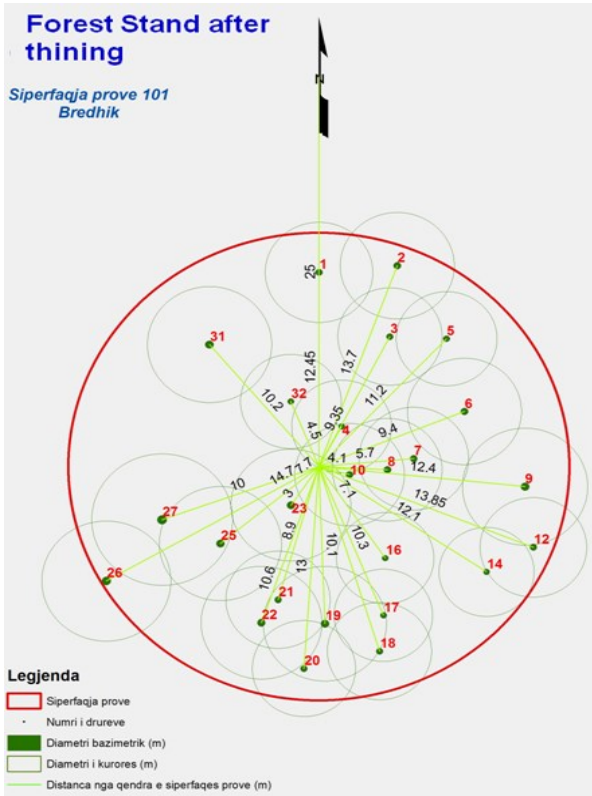


Fig. 7. Forest Stand structure after thinning



Fig 8. Seed Stand Bredhik (*Abies alba Mill.*) Plot nr.101

3. Seed Stand nr. 3-BOGAJ (*Abies alba Mill.*)



Fig. 9. Seed Stand Bogaj (*Abies alba L.*) Plot nr.101

Table 6. The distribution of trees by diametric categories in FS Bogaj- Plot Nr. 301.

Diametric category	Trees number/ha	Basimetric area m <sup>2</sup> /ha	The average size of tress		
			g <sub>mes</sub>	d <sub>g</sub>	h <sub>g</sub>
12	28	0.32			
16	14	0.28			
20	28	0.89			
24	14	0.64			
28	71	4.35			
32	71	5.69			
36	71	7.20	<b>0.1004</b>	<b>35.8</b>	<b>26.4</b>
40	85	10.66			
44	42	6.45			
48	57	10.24			
52	14	3.00			
Totally	495	49.73			

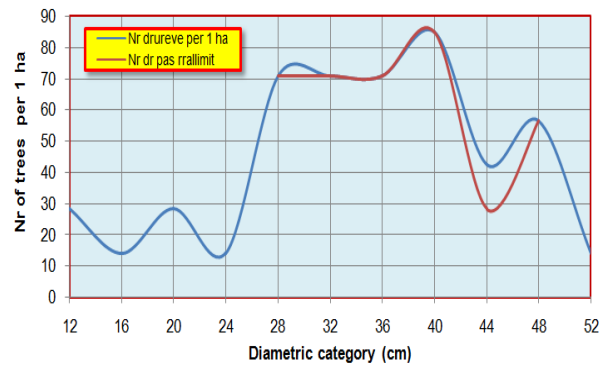


Fig. 10. The structure curve in relation to the diameter in the forest stand Bogaj-Plot Nr. 301

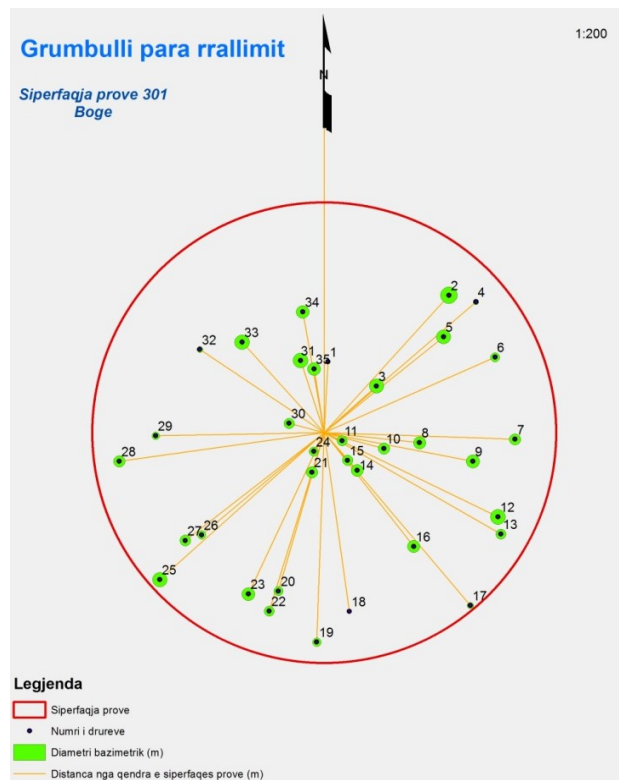


Fig. 11. Forest Stand structure before thinning

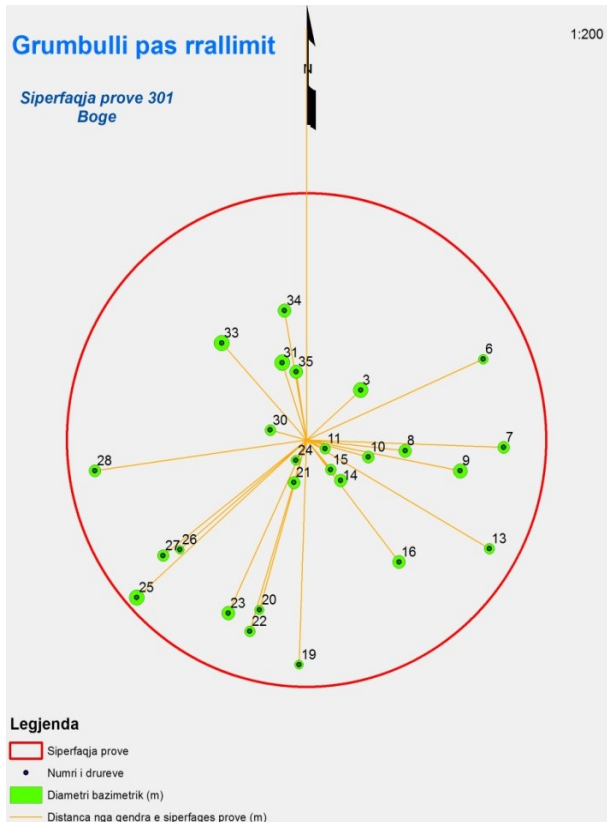


Fig. 12. Forest Stand structure after thinning

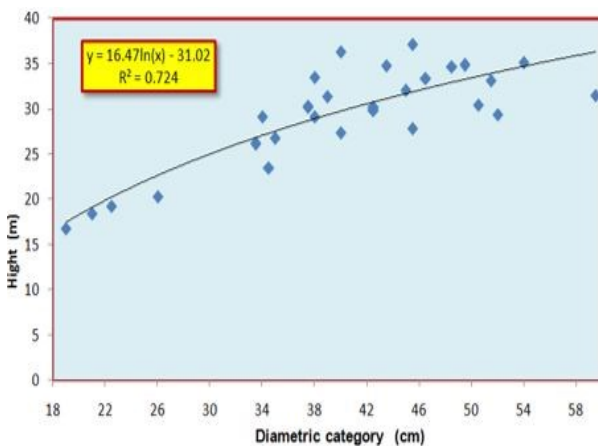


Fig. 13. Correlation between height and diameter in the forest stand Bogaj - Plot Nr. 301

#### IV. CONCLUSIONS

Natural forests are the base material for all seed sources and must generally be expected to represent an “average” quality. Trees growing in natural forests must be expected to show a high degree of adaptation to the prevailing environmental conditions of the site. Pollination is usually effective in natural forest.

However, due to seed dispersal, there is in natural forests a risk that trees form family groups i.e. neighboring trees are related or in extreme cases inbred. This will normally be broken in next generation plantation seed source. To assure genetic diversity is advised that seeds from natural forest be collected from widely separated trees.

Forests bounded by cultivated land. Even Seed sources in natural forests should accordingly typically be larger than plantations. Natural forests consist of indigenous species, which has spontaneously generated themselves on the location for many generations. Natural forests include both edaphic and climatic climax types and pioneer forests. Natural forests can be more or less influenced by culture, e.g. by logging /regeneration techniques, but the forests must not have been subject to regeneration by sowing or planting. However, enrichment planting and sowing using local material will still be considered natural forest. Selection of mother trees/ seed trees in natural forest usually gives little, if any, genetic gain since environment and age difference conceal or veil possible genetic variation.

However, relatively 10 evenaged natural forests exist for example as pioneer forest after land slide, burning, shifting cultivation or other disaster events. Many types of natural forests are nowadays protected if the total distribution of the forests may be large, some individual species could have a limited distribution within the forest. Natural forests are typically used to ‘mobilise’ the genetic reserve. Before undertaking the establishment of seed producing tree stands it is very important to first understand seed quality, since good quality seeds are needed to generate good quality trees. Bad quality seeds will produce trees with bad traits and/or that grow poorly. When dealing with seed quality there are three factors that have to be taken into consideration: genetic quality, physical quality and physiological quality:

The *physical quality* of seeds includes their size, color, age and seed coat condition. Cracks, damages or the presence of pests or diseases may all negatively affect germination.

The *physiological quality* of seeds includes the seed purity, moisture content and integrity of tissues, all of which will influence germination capacity.

The *genetic quality* is determined by the information contained in the genes within the seeds and is therefore inherited. High genetic diversity is a decisive factor in the success of any tree-planting project. Seeds of good genetic quality that are grown in the right environment and managed in the right way usually generate trees with desirable traits. It was very important to decide ahead of time on the right tree species to grow in the stand, since each species provides different products and is adapted to grow under specific ecological conditions. Additionally, the species selected should come from an area with similar environmental conditions as to those at the site where the stand will be established.

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    - The importance of seeds for Afforestation in Kosovo, ICOALS, 2018.
    - Rules and procedures for the selection of seeds in the natural beech forests (*Fagus sylvatica* L.) in Kosovo. Journal of Natural and Technical Sciences. 2019.

## AUTHOR'S PROFILE



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#### 1. Education

- Graduated from High School, Physics Course in 1984.  
 Graduated from the Faculty of Forestry, University of Belgrade in 1990. Actually PhD Student at the Agricultural University of Tirana (AUT), Faculty of Forestry Sciences, Department of Forestry.

#### 2. Work experience

- 1991-1997: Engineer of Management and Silviculture in Forest Directorate-Prizreni. - 1999- 2004: Engineer of Management, Protection and Silviculture in Forest Directorate in Viti-KS. From 2004-Present: Director of the Regional Directorate of the Kosovo Forest Agency, Gjilan-Kosovo.

#### 3. Professional development

- Cooperation with FAO, UNDP, SCANAGRI, SNV, etc., along with various domestic organizations, as part of international projects in the field of forests in Kosovo. Study visits related to silviculture and forest piles in countries such as: Macedonia, Austria, Turkey, Montenegro, Croatia, Slovenia, Bosnia & Herzegovina, etc. - Manager and leader of various projects in Kosovo: Treatment of New Forests in Kosovo,