CLASSIFICATION AND SELECTION OF SEED SOURCES IN KOSOVO

Bislim RRUSTEMI[1], Vath TABAKU[2]
[1] Kosovo Forest Agency, Gjilani Region, Kosovo
[2] Department of Forestry, Agricultural University of Tirana, Albania

ABSTRACT

*Qualitative seeds mean qualitative plants. Here, being aware about seed sources and to what extent they match the planting site and the purpose of the planting program is very important. Appropriate information about the location of seed sources would be useful. The following categories of seed sources ought to be defined and classified: i) seed collection zones, ii) identified and selected stands, iii) seed production areas and, iv) provenance seed stands. One of the purposes of classifying seed sources is to keep seed from different seed sources separate in order to be able to trace the ancestors of future plantings (Nikles and Newton1980). A seed source must consist of well distributed numerous trees on a given area making possible adequate inter-pollination so as to avoid increased risk of future inbreeding (Ballian 2011). Selection criteria were limited to a few phenotypic important traits estimated to have a relatively high heritability. The location of the seed sources of beech (Fagus silvatica **L.**), spruce (Piceaabies **Karst.**), fir (Abies alba **Mill.**), pine (Pinus nigra **Arn.**) were described and the boundaries were demarcated in the field. In default of information on origin careful estimation of the adaptability, growth and reproductive ability of the stand were carried out. It was important to select stands in which there is likely to be a significant genetic component in the phenotypic superiority. The first step taken in delineation was to produce an accurate map of the distribution of seed sources. The second step was to determine the original and large scale of populations. These main populations were then examined for lesser discontinuities resulting from soil types, mountain ridges and human interference.*

Keywords: *seed sources, seed orchards, improved genetic quality*

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1. INTRODUCTION

Approximately 44.7% (481,000 ha) of Kosovo`s area is under forest cover (KNFI 2013) and the assessment, management and development this forestry estate to create both employment and investment opportunity is of paramount importance (Fig. 1). Assessment and analysis of potential areas for afforestation has been carried out in the framework of the FAO project (Support for the implementation of the Forestry Strategy in Kosovo). This report provides important data about the number of seedlings that should be produced, as well as the range of required species. The objectives of the National Afforestation/Reforestation Program (NARP) cannot be achieved without the production of high-quality forest seedlings of the appropriate species. The target for the forest nursery will be the production of forest seedlings suited to the site types predefined as being suitable for afforestation in Kosovo (Willan 1985).

Future production strategies should focus on the production of seedlings, from indigenous seeds, collected from national seed stands. Current production capacity should also be increased and this will require significant investment in both staff and mechanization. Indigenous seed stands selected for seed collection should cover all species outlined in the NARP. Future nursery production strategies will also need to consider the production of endangered species (Barner and Willan 1983).

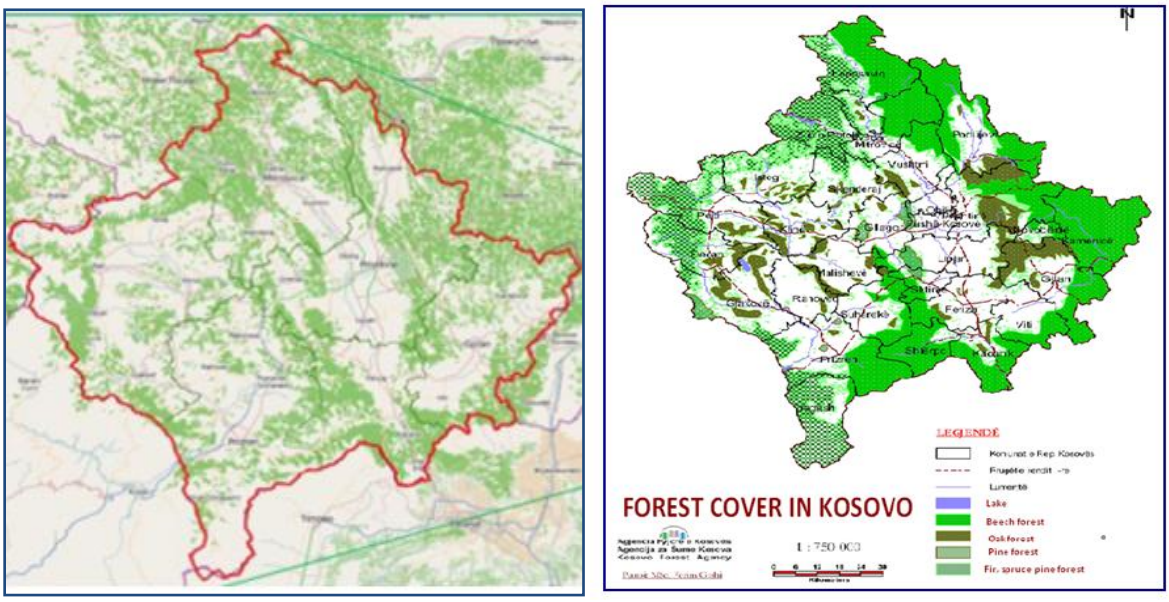


Fig.1: Location and forest cover of Kosovo.

Protecting the native genetic pool particularly of endangered plant species will ultimately make a significant contribution towards protecting the biodiversity of Kosovo. The advantages of focusing on native species are as follow: i) the genetic profile of the indigenous trees and shrubs which are of local origin will complement local growing conditions. The key principle should be the right tree in the right place, ii) planting trees that are better adapted to local site conditions will lead to a better plant survival rate thus avoiding the significant cost of replacing, iii) planting seedlings grown from imported seeds will affect the local genetic characteristics of certain species. This can manifest itself through delayed sprouting, delayed flowering and fructification. This in turn can disrupt the balance between the indigenous tree species and the wild life they support and, iv) using native seedlings will reduce transport costs.

The choice of seed source may be decisive for the success or failure of plantings (Willan 1984). To avoid mistakes the consumer must know which seed sources are available, what they are selected for and to what extent they match the planting site. 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 (Gavranović *et al*., 2013). A seed source must consist of: i) trees of such an age and development that criteria for selection can be clearly judged and, ii) well-distributed numerous trees on a given area making possible adequate interpollination as to avoid increased risk of future inbreeding (Barner1975). Selection criteria were limited to a few phenotypic important traits estimated to have a relatively high heritability. The location of the seed sources in Kosovo [beech (*Fagus silvatica***L.**), oak (*Quercus s*.), spruce (*Piceaabies* **Karst.**), fir (*Abies alba* **Mill.**), pine (*Pinus nigra* **Arn.**)] 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 (OECD 1974). Based on the information collected at the regional offices of the Kosovo Forest Agency (KFA), 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. MATERIALS AND METHODS

Delineation process requires two important processes: i) the production of an accurate map of the distribution of seed sources in all Kosovo. It was important to select stands in which there is likely to be a

significant genetic component in the phenotypic superiority and, ii) the determination of 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.

2.1. 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 (OECD 1974). 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 (OECD 2013):
Uniformity: The stands must show normal degree of individual variation in morphological characters.
Volume production: Volume production of wood is normally an essential criterion for acceptance of selected stands. Volume production of wood must normally be superior.
Wood Quality shall be taken into account and in some cases, may become essential criterion.
Form & Growth Habit: The trees in selected stands must show particularly good morphological features, especially straightness and circularity of stem, favorable branching habit, small size branches and good natural pruning. The proportion of forked trees and with spiral grain should be low.
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.
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.

Genetic history must be carefully checked.
Studying the artificial selection to which the stands have been subjected and clarifying whether the stand had derived from a seed lot representing a few parent trees only or from a larger population is very important. Measures must be taken to reduce the risk of contaminating pollen from foreign sources. Where isolation is difficult, a minimum size of 5 ha of the stand may be recommended and seed should not be collected along borderline of selected stand.

3. RESULTS

In the 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: i) incorrect species selection in that the selected species is not compatible with local ecological conditions within the afforestation area, ii) lack of maintenance within the afforestation area post planting, iii) poor quality seed which was initially used to produce the seedlings and, iv) planting at lower altitudes where the species planted is in truth more suited to higher elevations.
Given the aforementioned deficiencies and the importance of the qualitative seeds, selecting native seed stands within Kosovo which have a defined, known phenotype and genotype and where the stand could be classed as being of "high quality" would be very important. Consequently, site inspection of forest stands was carried out involving a test for the conditions of the forest stands. Stands that did not fulfill one of the aforementioned criteria were excluded from the list of candidates for seed stands. Stands that fulfilled these criteria at first glance were accepted. However, measurements and observations for a final selection of seed stands ought to be made. Information about selected seeds stands is in the Table 1 reported.

Table 1: Selected seed stands in Kosovo

Nr	Management Unit	Plot Nr.	Species	Area plot Ha	Area of seed stand
1	Bredhik	33/1	*Abies alba* L.	37.86	6.10
2	Koritnik	15/1	*Pinus heldreichii*	**90.30**	**5.70**
3	Bogaj	32/1	*Abies alba* **L.**	**23.59**	**5.50**
4	Ahishte	31/1	*Fagus sylvatica* **L.**	**15.20**	**5.50**
5	Deçan	57/2	*Picea abies* **Karst.**	**36.80**	**6.80**
6	Dragsh	54/1	*Pinus nigra* **Arn.**	**19.30**	**5.20**
7	Blinaja	33/1	*Quercus petrea* **L**	**21.50**	**9.70**
8	Gjilan	24/1	*Quercus cerris* **L.**	**25.40**	**6.80**

3.1. Characteristics of selected seed stands

Dendrometric characteristics of the trees in the seed stands, by which the selection of plus seed stands was made is detailed in the Table 2.

Table2. Dendrometric characteristics of trees for the main species in the forest stand.

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 Heigh	09	10	< 60	09	10	18	20
Symmetric	74	80	1/3 of Heigh	16	15	60-90	18	20	18	20
Flag			1/4 of Heigh	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	Weak			05	05
Brush	09	10	Good	28	30	Good			14	15
Flat	65	70	Very good	56	60	Very good			56	60
Indifferent	00	00	Great	09	10	Great			18	20
g) Trunk quality (Bifurcation)	Number	%	h) Branch diameter	Number	%	i) Number of branches in annual circles (for years of age)			Number	%
	93	100		93	100				93	100
Low	00	00	Very large	05	05	4			65	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			k) cleanliness of trees trunk	Number	%	l) Damages			Number	%
down			up							
	Number	%	Number	%		93	100		93	100
0.2 m	09	10	18	20	Weak	09	10	Strong	00	00
0.4 m	18	20	19	20	Good	28	30	Medium	00	00
0.6 m	19	20	37	40	Very good	47	50	Weak	19	20
0.8 m	47	50	19	20	Great	09	10	Does not exist	74	80
m) Infections from disease and Insects	Number	%	n) Twisted trunk	Number	%	o) Rude bark finish			Number	%
	93	100		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			Number	%
	93	100		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								

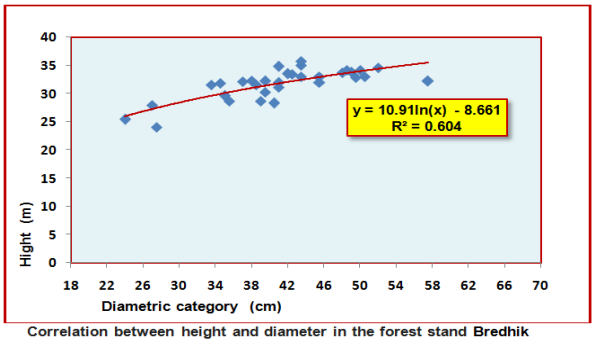
Here, a brief information on the inspected piles is provided along with the opinion at the end of each description, if accepted as seed stand. The information has been obtained based on the test surfaces of each seed cluster and is as follows:

1. Two pictures taken at the center of the test surfaces to show the quality of the seed stand.
2. Table on the distribution of trees by diametric categories in which forest stand.
3. Graphic on the correlation between height and diameter in the forest stand.
4. Graphic on the structure curve in relation to the diameter in the forest stand.
5. Graphic on the forest stand structure before and after thinning.

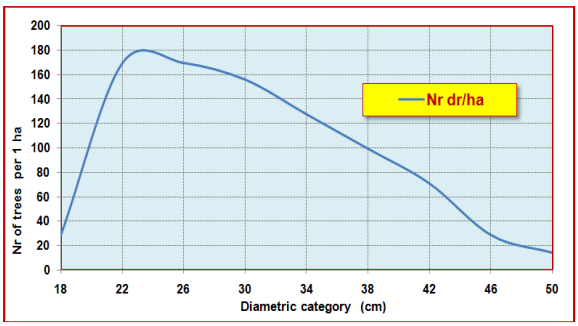
1. Seed Stand no. 1 Bredhik (*Abies alba* L.)

The distribution of trees by diametric categories in FS Bredhik

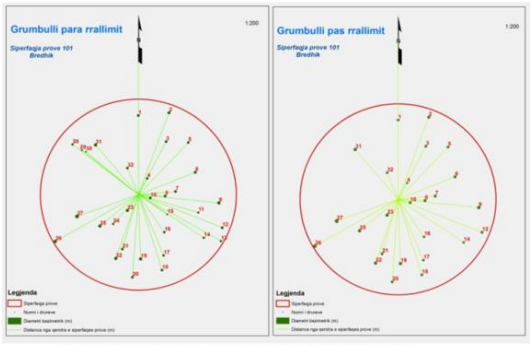
Diametric category	Trees number/ha	Basimetric area m² /ha	The average size of tress		
			g_{mes}	d_g	h_g
22	14	0.54			
26	28	1.50			
30	0	0.00			
34	57	5.14			
38	85	9.62	0.137	41.7	32.0
42	127	17.63			
46	42	7.05			
50	85	16.66			
54	0	0.00			
58	14	3.74			
	453	61.88			



Correlation between height and diameter in the forest stand Bredhik



The structure curve in relation to the diameter in the forest stand Bredhik

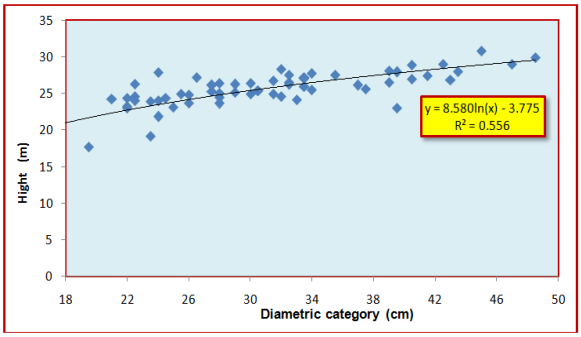


Forest Stand structure before and after thinning

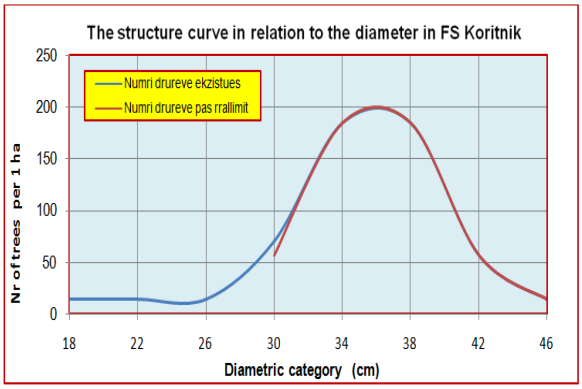
2. Seed Stand nr.2-Koritnik 2 (*Pinus heldeichii*)

The distribution of trees by diametric categories in FS Koritnik

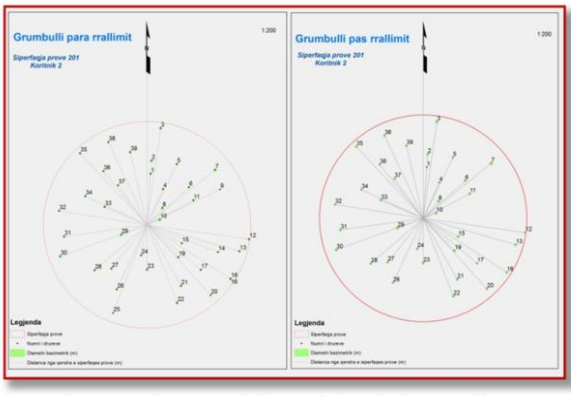
Diametric category	Trees number/ha	Basimetric area m² /ha	The average size of tress		
			g_{mes}	d_g	h_g
18	14	0.4			
22	14	0.5			
26	14	0.8			
30	71	5.0			
34	184	16.7	**0.0985**	**35.4**	**21.2**
38	184	20.9			
42	57	7.8			
46	14	2.4			
	552	**54.4**			



Correlation between height and diameter in the forest stand Koritnik



The structure curve in relation to the diameter in the forest stand Koritnik

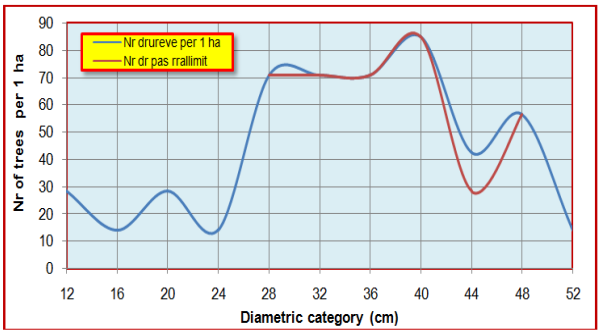


Forest stand structure before and after thinning operation

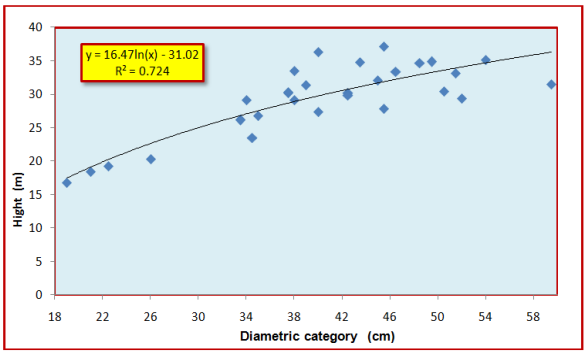
3. Seed Stand nr.3-BOGAJ *(Abies alba L.)*

The distribution of trees by diametric categories in FS Bogaj

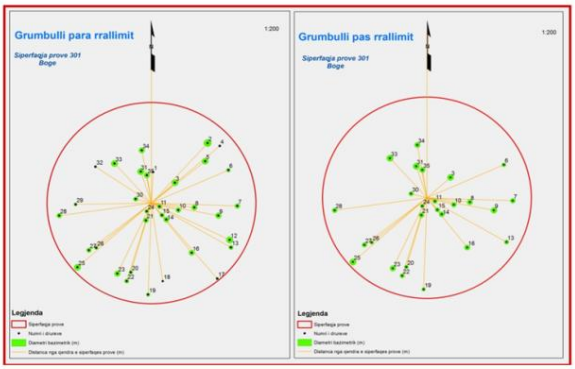
Diametric category	Trees number/ha	Basimetric area m^2 /ha	The average size of tress		
			g_{mes}	d_g	h_g
12	28	0.32			
16	14	0.28			
20	28	0.89			
24	14	0.64			
28	71	4.35			
32	71	5.69			
36	71	7.20	**0.1004**	**35.8**	**26.4**
40	85	10.66			
44	42	6.45			
48	57	10.24			
52	14	3.00			
Totali	**495**	**49.73**			



The structure curve in relation to the diameter in the forest stand Bogaj



Correlation between height and diameter in the forest stand Bogaj

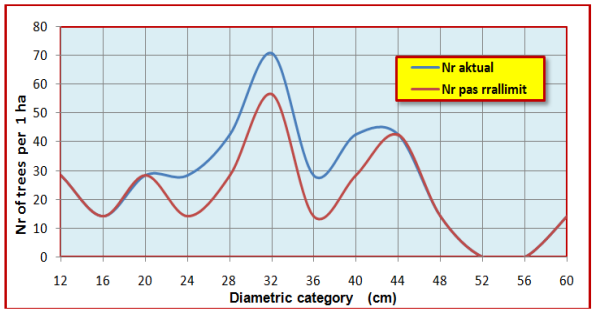


Forest stand structure before and after thinning operation in FS Bogaj

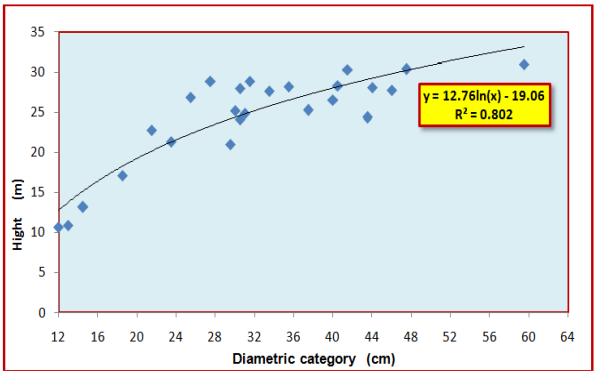
4. Seed Stand nr. 4-Ahishta (*Fagus sylvatica* L.)

The distribution of trees by diametric categories in FS Ahishta

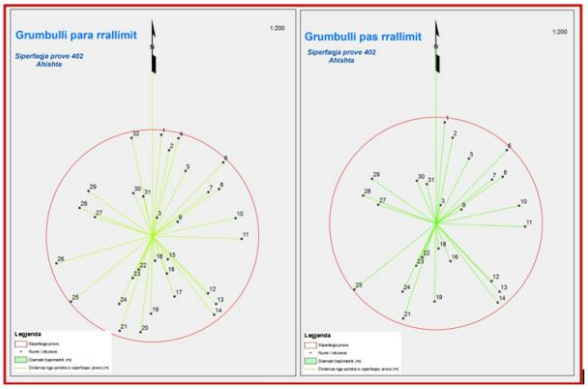
Diametric category	Trees number/ha	Basimetric area m² /ha	The average size of tress		
			g_{mes}	dg(cm)	hg(m)
12	28	0.32			
16	14	0.28			
20	28	0.89			
24	28	1.28			
28	42	2.61			
32	71	5.69			
36	28	2.88	0.091	34.1	26.0
40	42	5.33			
44	42	6.45			
48	14	2.56			
60	14	4.00			
Totali	**354**	**32.29**			



The structure curve in relation to the diameter in FS Ahishta



Correlation between height and diameter in the forest stand Ahishta

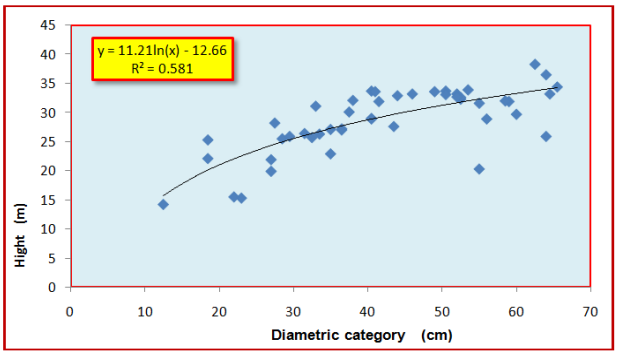


Forest stand structure before and after thinning operation in FS Ahishta

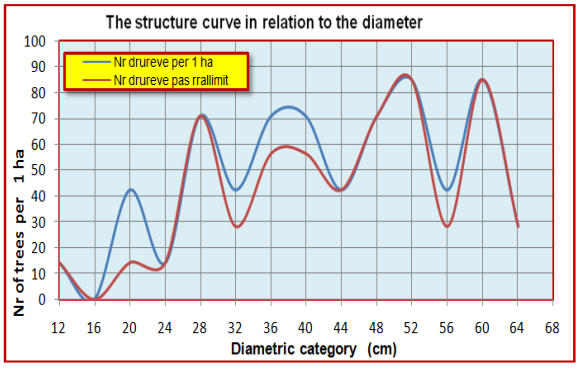
5. Seed Stand nr. 5- Deçan(Piceaabies)

The distribution of trees by diametric categories in FS Deçan

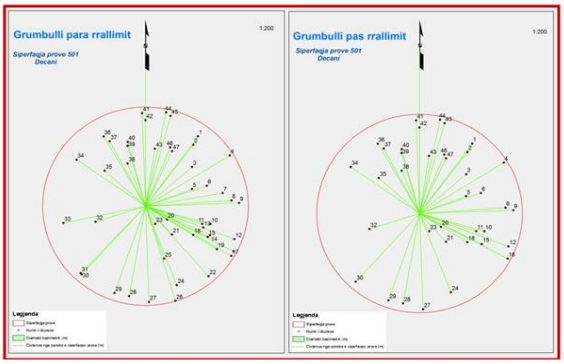
Diametric category	Trees number/ha	Basimetric area m² /ha	The average size of tress		
			g_{mes}	dg(cm)	hg(m)
12	14	0.160			
20	42	1.333			
24	14	0.640			
28	71	4.354			
32	42	3.412			
36	71	7.198	0.1572	44.8	29.97
40	71	8.886			
44	42	6.451			
48	71	12.796			
52	85	18.021			
56	42	10.450			
60	85	23.993			
64	28	9.099			
Totali	**679**	**106.8**			



Correlation between height and diameter in the forest stand Deçani



The structure curve in relation to the diameter in FS Deçan

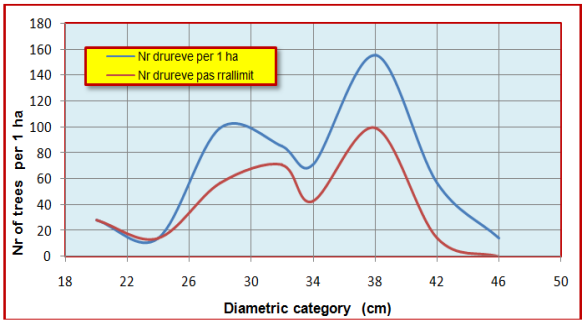


Forest stand structure before and after thinning in FS *Deçani*

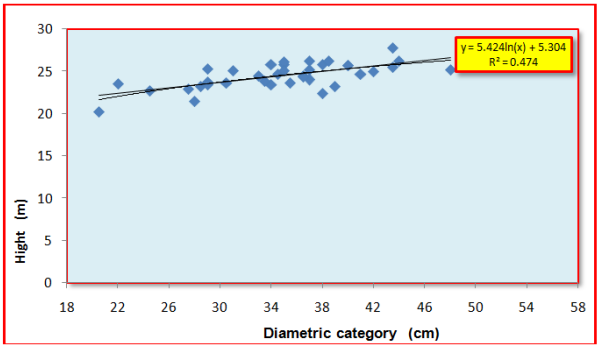
6. Seed Stand nr. 6-Dragash(*Pinus nigra)*

The distribution of trees by diametric categories in FS Dragash

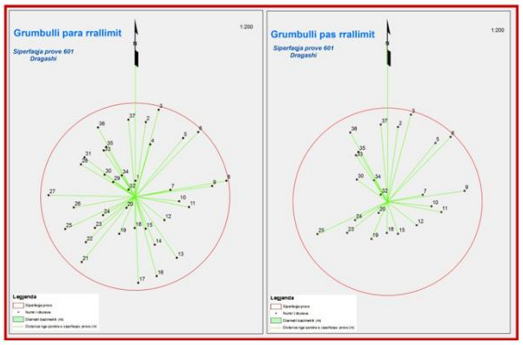
Diametric category	Trees number/ha	Basimetric area m^2 /ha	The average size of tress		
			g_{mes}	dg(cm)	hg(m)
26	57	3.0			
30	99	7.0			
34	142	12.8			
38	156	17.6	0.095	34.9	22.2
42	42	5.9			
46	14	2.4			
Totali	509	48.7			



The structure curve in relation to the diameter in FS Dragash



Correlation between height and diameter in the forest stand Dragash

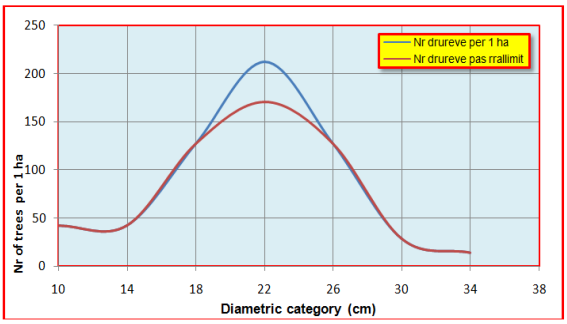


Forest stand structure before and after thinning in FS *Dragash*

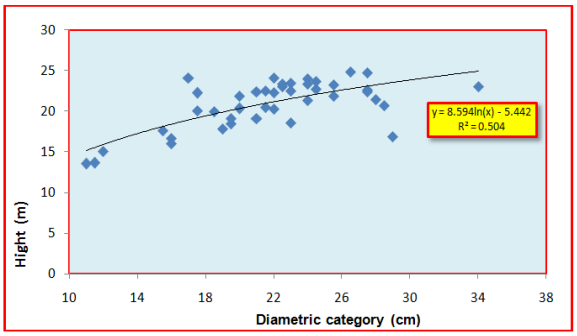
7. Seed Stand nr. 7- Blinaje (*Quercus petrea)*

The distribution of trees by diametric categories in FS Blinaja

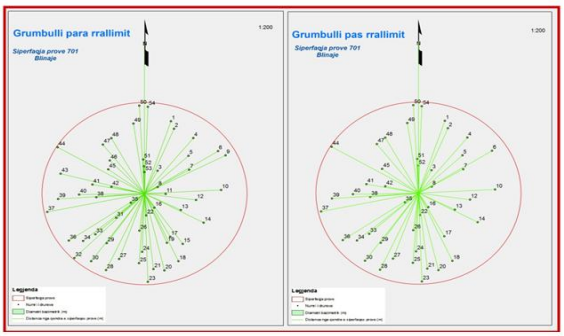
Diametric category	Trees number/ha	Basimetric area m^2 /ha	The average size of tress		
			g_{mes}	dg(cm)	hg(m)
10	42	0.33			
14	42	0.65			
18	127	3.24			
22	212	8.06	0.03757	21.9	21.1
26	127	6.76			
30	28	2.00			
34	14	1.28			
Totali	594	22.33			



The structure curve in relation to the diameter in FS Blinaja

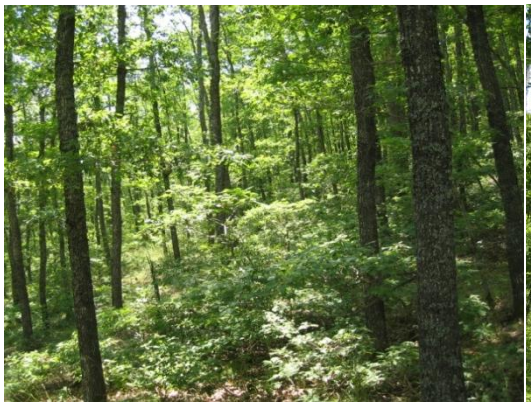


Correlation between height and diameter in the forest stand Blinaja



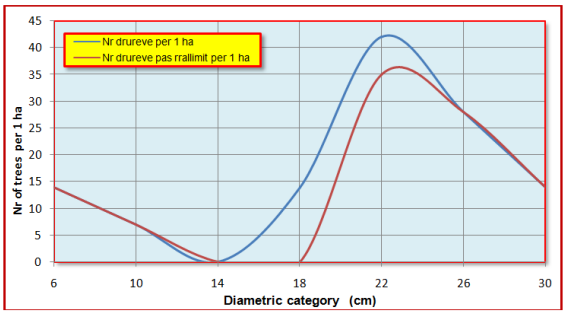
Forest stand structure before and after thinning in FS Blinaja

8. Seed Stand nr. 8- Gjilan(*Quercus cerris)*

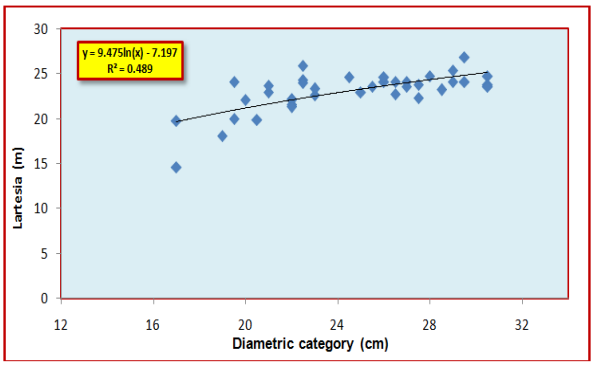


The distribution of trees by diametric categories in FS Gjilani

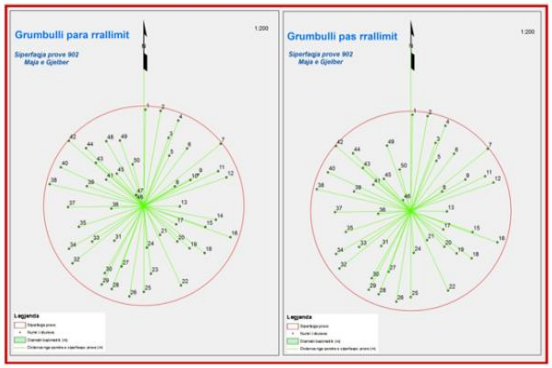
Diametric category	Trees number/ha	Basimetric area m² /ha	The average size of tress		
			g_{mes}	dg(cm)	hg(m)
12	14	0.16			
16	36	0.71			
20	135	4.24			
24	149	6.74	0.046	24.1	23.0
28	149	9.18			
32	50	4.00			
Shuma	547	25.02			



The structure curve in relation to the diameter in FS Gjilan



Correlation between height and diameter in the forest stand Gjilani



Forest stand structure before and after thinning in FS Gjilani

4. CONCLUSIONS

Natural forests are the base material for all seed sources and must generally be expected to represent an "***average***" quality (tab. 4). Trees growing in natural forests are 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. 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.

Table 4: Key Dendrometric characteristics of the seed stands

Key Dendrometric characteristics	***1.Bredhi k*** Abies alba	***2.Koritni k*** Pinus heldreich	***3.Bogaj*** Abies alba	***4.Ahisht a*** Fagus sylvatica	***5.Deça n*** Picea abies	***6.Shtim e*** Pinus nigrae	***7.Blinaja*** Quercus petrea	***8.Gjilan*** Quercus cerris
Average diameter	**41.7**	**35.4**	**34.1**	**34.1**	**44.8**	**34.9**	**21.9**	**24.1**
Average height (m)	**32.0**	**21.2**	**26.0**	**26.0**	**29.9**	**22.2**	**21.1**	**23.0**
Trees number per	**453**	**552**	**495**	**354**	**679**	**509**	**594**	**547**
Basimetric area	**61.9**	**54.4**	**49.7**	**32.3**	**106.8**	**48.7**	**22.3**	**25.1**
Stand volumme	**774**	**664**	**648**	**870**	**507**	**491**	**518**	**586**
Age (years)	**97**	**117**	**90**	**136**	**105**	**74**	**84**	**78**

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 forests bounded by cultivated land. Even 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. Finally, if the species selected is crosspollinating and is new to the area, it is important to ensure that the right pollinators are present.

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