SEED STAND ESTABLISHMENT PROCEDURES AND RULES FOR THE NATURAL BEECH FORESTS (*Fagus sylvatica* L.) IN KOSOVO

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

---

ABSTRACT

European beech (*Fagus sylvatica* L.) is the most important broad-leaved tree species in Kosovo, both in economic and environmental terms. It is found as a dominant and a subordinate species in mixture with conifers. As the changing demands of today require a widened scope of forest management for sustainable forestry emphasizing biodiversity and naturalistic forest management, adjustments have been made through a conversion to more site adapted beech forests. The high diversity in site conditions, ownership, economic and socio-cultural conditions require strategies adapted to the local and regional needs like seeds genetically qualitative. Higher resistance of forests will increase economic and social benefits of forests and reduce the risks by maintaining sustainable forestry. Seed stand establishment is a means to address genetic qualitative seeds. In addition, improved seed quality and ease of cone collection provide extra benefits. To realize these benefits detailed procedures for stand selection, mapping, inventory, thinning, isolation, registration and future management are required which are suitable for application in the unmanaged forests stands of beech. The selection and establishment of seed stands represents a quick and inexpensive method of obtaining seed of improved genetic quality. This paper aims to set down establishment procedures for seed stands in the natural beech forests of Kosovo. A seed stand may be defined as a plus forest stand upgraded, opened by removal of undesirable individuals and cultured for abundant seed production. This description corresponds with the OECD (Organization for Economic Cooperation and Development) category of "selected reproductive material" and that seed stands should follow these guidelines. The continuous cutting of forest trees for industrial and fuelwood purposes in Kosovo is the source of severe dysgenic exploitation which can be mitigated by putting aside high-quality stands for seed production. In the natural beech forests of Kosovo, comprehensive surveys to locate the best stands is challenging for the staff of Kosovo Forest Agency (KFA). In the present study, KFA has been very helpful for the selection of sites and inventory of seed stands. The

inventory of seed stands aimed at providing information about the quantitative data such as number of trees per hectare, tree height, diameter, basal area and qualitative traits such as stem forking, stem straightness, branch characters and natural pruning.
Keywords: European beech, genetic quality, seed stand, reproductive material, regeneration

1. INTRODUCTION

European beech (Fagus sylvatica L.) is widely distributed across Europe and is one of the dominant forest tree species in Central Europe (Ellenbergh1988). In total, beech covers an area of roughly 14 million hectares and, thus, is ecologically and economically one of the most important species in European forestry (Gavranović*et al*., 2013). In Kosovo, beech is the most common tree species as well. Forest area in Kosovo is fairly stable at approximately 481.000 ha (44.7% of total area). Pure broadleaved forests cover almost 83% of the forest area (KNFI 2013). Amongst the trees, Fagus species contribute with 46% of the volume, whereas Quercus species represent 23%. The selection and establishment of seed stands represents a quick and inexpensive method of obtaining seed of improved genetic quality. Up to now all seed collection in Kosovo has been made in the form of general collections of provenance identified material with control to avoid collection from particularly poor phenotypes.

The use of seed from forest tree species of known origin is explicitly prescribed by European Union regulations-1999/105/EC (Anonymous 1999). These set out the importance of demarcation of regions of provenance to control the movement of forest reproductive material and to avoid its being used in unsuitable environmental conditions (Ballian 2011). Seed regions are thus the first and fundamental level in the management of genetic resources for the production of forest reproductive material. This paper aims to set down establishment procedures for seed stands in the beech natural forests in Kosovo in terms of stand selection, inventory, stand treatment, isolation and their future management. This research will thus form the basis for the future planned use of beech reproductive material, the preservation of its indigenous genofund and the definition of regions of provenance.

A seed stand may be defined as a plus stand that is upgraded and opened by removal of undesirable individuals and then cultured for abundant seed production (Barner1973). This description corresponds with the OECD (Organization for Economic Cooperation & Development) category of "selected reproductive material" (OECD 1974) and it is intended that selected seed stands should follow these guidelines. A further important role of seed stands is the conservation of genetic resources. The high rate of cutting for industrial uses and fuelwood in many parts of Kosovo has created a situation

of severe dysgenic exploitation which can be mitigated by setting aside high-quality stands for seed production. General aspects of seed stand establishment have been frequently reviewed in literature (Barrett 1980). These three main objectives of seed stand establishment have been widely recognized) production of seed of improved genetic quality, ii) increase in the quantity and physical quality of seed produced and, iii) concentration of seed collection in small areas thereby lowering costs and making control easier.

2. MATERIALS AND METHODS

Comprehensive surveys in the natural beech forests to locate the best stands are challenging for the Kosovo Forest Agency (KFA) staff. In the present study, KFA has been very helpful for the selection of sites and the inventory of seed stands. In addition, aerial photographs proved to be useful for stand selection. Finally, all available information on stand history in terms of regeneration, thinning and fires served as a further guide for final selection. Stand selection is based on a complex factors and represents one of the most critical and problematical stages in seed stand establishment. First, it was important to locate seed stands in the most important provenance regions and factors like altitude, climate and soil where considered as making up the representative conditions. Second, the area of stand required to supply enough seed to meet likely demands.

2.1. Inventory

The inventory of seed stands is very important because of: i) the comparability of two or more alternative stands for stand selection, ii) the calculation availability of the selection intensities for thinning and, iii) the assessability of the changes in stocking and phenotypic quality after thinning. The inventory should aim to yield information on both quantitative characters such as number of trees per ha, tree height and diameter, and basal area and qualitative traits such as stem forking, stem straightness, branch characters and natural pruning. These phenotypic characters may be divided into quality classes to form a basis both of qualitative inventory assessment and guidelines for marking thinning. The study was carried out in the predetermined experimental plots of beech seed stands—each plot 706.5m^2. In each plot, a census of all living trees with diameter at breast height (DBH)>2.5 cm was performed. For each tree, the following data were collected: x, y coordinates according to polar coordinates; DBH measured by a Caliper; total tree height and height-to-base of the live crown, measured with Vertex-Forestor 3 and crown projection was inventoried, measuring crown radii in 8 cardinal directions with crown mirror. Age was assessed using a sample of cores

extracted at a height of 1.3 m above ground. Rings were counted in the laboratory.

3.2. Mapping

A map at the scale between 1:5.000 and 1:10.000 would help to define seed stand boundaries, designing inventory sampling, fixing isolation zones, control of thinning and for subsequent registration and control of seed collection. The map should outline roads, tracks, rivers, gullies, ridges and the stand limits and can be readily drawn from aerial photographs which also help in studying topography and stand distribution. Stand boundaries may be demarcated on the map and where possible should follow features such as tracks, rivers or ridges.

3.3. Selecting of Seed Stands

Criteria for the acceptance of seed stands

All the stands proposed for inclusion in the National Register were inspected and the followingcriteria for the selecting and acceptance of seed stands (OECD 2013) were considered:

Origin: The clear designation of the stands as material of indigenous and non-indigenous origin.

Location and isolation: Stands need to be at an appropriate distance from poor stands of same species.

Effective size of population: Stands must consist of groups of trees, well distributed & sufficiently numerous to ensure adequate interpollination.

Age and Development: Stands need to consist of trees of an age at which acceptance criteria can be clearly judged.

Uniformity: The individuals of the stand must show a normal degree of variation in morphological characters.

Adaption: There must be evidence that the material is acceptably adapted to the region of provenance or seed zone.

Health and resistance: Stands should be healthy and show maximal resistance to harmful organisms and to external conditions.

Production and wood quality: Where volume production is an essential criterion for approval it must be superior to the accepted mean under similar ecological conditions.

Form or growth habit: Proposed stands need to show particularly good morphological features especially straightness and circularity of stem, small size of branching and natural pruning; a low proportion of forked trees.

3. RESULTS

3.1. Stand structure

Number of stems per hectare, basal area per hectare, volume per hectare, canopy cover and average parameters of trees are in the Figure 3 depicted. A volume exceeding 1000 m^3/ha, like that recorded in FS-Ahishta, is unusual even for old-growth beech forest stands (Calamini *et al*., 2011) and it is almost 4.6 times larger than the mean volume (245 m^3/ha) estimated by Kosovo National Forest Inventory (2013) for beech forests located in the same region. The stem number-diameter distribution is in Figure 4 depicted. Forest stand structure before/after thinning operation in FS-Ahishta is in the Figure 5 depicted.

3.2. Stand Selection

In general, it is preferable to locate stands on nationally owned land. Access must be adequate to allow entry of a 4-wheel drive vehicle for cone collection operations. The lack of a market for small round-wood can be a major obstacle to thinning and this should be considered before selecting the stand. Finally, the ease of protection of the stand from serious fires or illegal cutting may also influence stand selection. Given such a large number of factors it may not be possible to satisfy all criteria and find the ideal stand. In Kosovo, the stand requirements can usually be met for two or more alternative locations within a given provenance region for *F. sylvatica* and final selection can be based on the all-important factors of access, sale of thinning and protection.

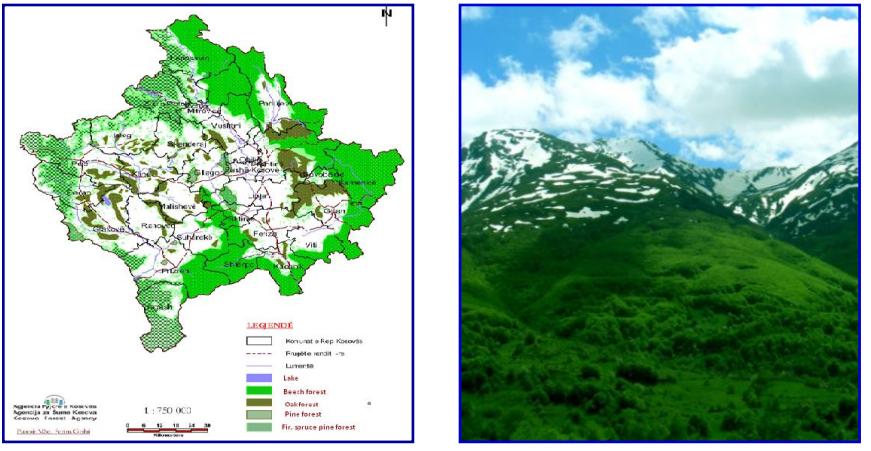

Fig. 1: Forest cover in Kosovo, Beech Forest in Sharri Mountain

Fig.2: Beech stand selected as seed stand

Diametric category	Trees number/ha	Basimetric area m^2 /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			

Fig.3: The distribution of trees by diametric categories

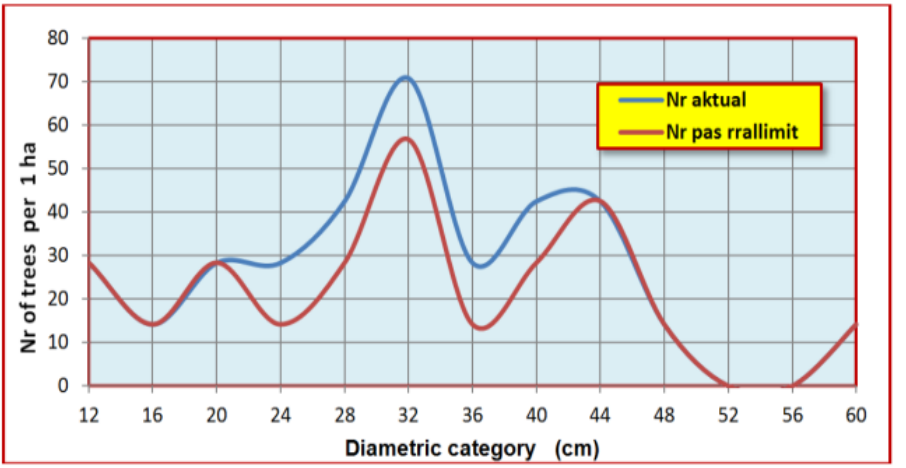

Fig.4: Structure of the beech stand

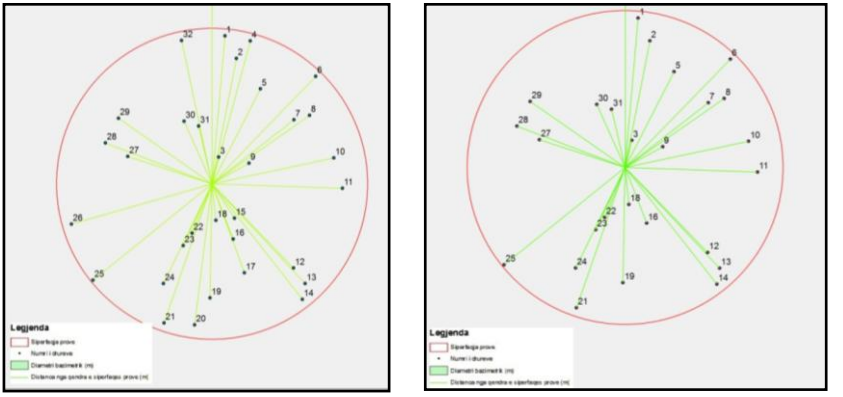

Fig.5: Forest stand structure before and after thinning operation in FS Ahishta.

3.3. Selection of plus trees

Schreiner (1963) said that plus trees are used for: i) the establishment of seed orchards, ii) direct silvicultural purposes, if a clonal propagation by means of cuttings is possible and, iii) use in hybridization, i.e. in tree breeding work. A number of problems and authors' views about plus tree selection are here discussed. The selection of plus trees should be carried out in seed production areas where an inventory was previously 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 that are measurable, rather than with those which

are expressed in a descriptive manner. Schreiner (1963) recommended that selection should be restricted to those trees which exceed the mean by two or three. Andersson (1962) stated that selection of plus trees has been performed so far on the basis of a relative estimation of the growth rate, stem form, saw-timber grade, wood quality, seed production and resistance. Selection of plus trees is much more successful if it is made for one or two from this tree characters. Moreover, it is very difficult to find a tree which is excellent in many characters.

The correlation between individual characters is very important for the selection of plus trees. Selection process requires excellent acquaintance of biological aspects of the individual species. Such data on local species and ecotypes enables selection of the most suitable trees for further improvement work and establishment of seed orchards, or for immediate use for silvicultural purposes. Beeches have different flushing time within provenances and between provenances Hoffmann (1959). 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. In tree improvement work more and more attention is paid to wood quality, i.e. anatomical and physical properties of wood. Mitchell (1956) said that the most important properties are: density, ratio between early wood and latewood within the growth ring, number of growth rings per centimeter, fiber length and fibril orientation.

3.4. Control and registration of plus trees

The supply of forest tree seed in Sweden has been especially actualized in the last decades. Consequently, a national programme for the production of forest seed in plantations has been elaborated (Andersson 1963). In order to obtain the requisite material for breeding and plantation work intensive and comprehensive selection has been carried out for several years and is still continuing in certain regions or provenance areas. The plus trees selected are carefully measured and assessed in respect of wood specific gravity, growth rate, stem form, and branch characters - a so-called *phenotype control* (Forshell1963).

3.5. Choice of stands for plus trees selection

Many theoretical and practical problems arise related to plus tree selection. One important question is the types of stand for the plus tree selection. Plus, trees - in respect of one or two desirable properties - can be found in any type of stand. If we desire to select plus trees which are plus, e.g. in growth rate and other characters influenced by competition, this selection can most readily be made in stands where the trees have the best opportunity of revealing their inherent constitution, i.e. in sparsely to normally stocked stands on good sites. In addition to these aspects of stands selection, plus tree selection should be

concentrated on seed stands or seed production areas (Matthews 1963) which consist of *plus stands and almost plus stands*, and on middle-aged stands which, in relation to age, site and climatic conditions, are well-developed and show particularly good morphological features. Selection of these seed stands is a great achievement in the preservation of valuable tree populations for silviculture.

3.6. Isolation

Isolation of seed stand from inferior pollen sources outside the seed stand is very important for an appropriate genetic improvement. Complete isolation is impossible due to long-distance travel of windborne pollen and location of seed stand in heavily forested areas. Heavy production of pollen within a seed stand is most important for diluting outside contamination effects. Area and shape of the seed stand are also important as contamination decreases rapidly away from the stand boundaries towards the center. The most practical way to isolate a stand is to create a 100 m wide isolation fringe around the stand which is thinned to remove all inferior phenotypes. However, well-formed trees remain within the isolation fringe as a physical barrier and source of significant quantities of pollen. Seed collection is restricted to the central part of the stand surrounded by this 100 m wide dilution zone. The prevailing wind direction and topography define the isolation zone

4. Registration

The Local Office, the District Office and the Central Office of the National Forest Authority (NFA) are the responsible bodies for the inventory seed stands. The inventory provides information about location and stand boundaries. In addition, land ownership is an unavoidable data.

5. Future management and seed collection

Long-term studies addresses the management of seed stands for the future. Depending on the response of the tree crowns, it is likely that a further thinning will necessary within five years to reduce stocking to the final goal of around 150 stems per hectare.

Application of nitrogenphosphate fertilizers is the most generally accepted means of increasing cone crops. However, information on dosage rates, timing of application and cost benefit analysis of such operations lacks. The response of cone and seed production to fertilization should be assessed based on small-scale trials as seed stands are established. Cone collection in seed stands must be strictly controlled as collection ought to remain within the limits in the isolation zone. Preventing trees from damages is of paramount importance for the cone crops in the coming years. The careful use of cone cutters and trained seed collectors are important for the sound fruits.

6. CONCLUSIONS

Seed stand establishment provides a useful interim measure to obtain seed of improved genetic quality until more highly selected material is available from seed orchards. Despite the limited selection intensities that can be achieved through thinning, genetic gains for highly heritable characters such as stem straightness as high as 5-6% are expectable from seed stands which is of great benefit to national reforestation programs and higher prices for seed exports. In addition, qualitative seeds and greater ease of cone collection provide extra benefits.

Data show that in Kosovo thinning wood is profitable for the seed stand establishment as costs could be covered. Seed stands are important for the conservation of genetic resources. The continuous cutting of forest trees for industrial and fuelwood purposes in Kosovo is the source of severe dysgenic exploitation which can be mitigated by putting aside high-quality stands for seed production which will act as in situ conservation stands. Only a very small area of seed stands has been currently established in the natural beech forests of Kosovo. Ideally a sufficient area of seed stands to supply seed for both national use and export should be established in each important provenance region.

REFERENCES:

Andersson E. 1962. Die Fichtenzüchtung in Schweden. –Svensk Pappers tidning Sv. **65**: 44-55.

Andersson E.1963. Seed stands and seed orchards in the breeding of conifers. World consultation on forest genetics and tree improvement. 8/1, Stockholm.

Anonymous. 1999. Council Directive 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material. *Official Journal* **L 011** (15/01/2000): 17-40.

Ballian D. 2011. Basic principles of zoning of seed zones on genetic principles. Croatian Academy of Science and Arts. *Works*.**12/13**: 18-41.

Barner H. 1973. Classification of sources for procurement of forest reproductive material. Report FAO Danida Training Course on Forest Tree Improvement. Kenya: 110-138.

Barnes RD, Gibson GL, Bardley M. 1980. Variation and genotype environment interaction in international provenance trials of *pinus caribaea*

var. Hondurensis and its implications for population improvement and productivity of fast-growing species. Águas de S. Paulo, Brazil, August 1980.

Barrett WH. 1980. Seleccion y manejo de rodales semilleros conespecial referencia coniferas. Report FAO-DANIDA. Training Course on Forest Tree Breeding. Venezuela, January 1980: 158-165.

Calamini G, Maltoni A, Travaglini D, Iovino F, Nicolaci A, Menguzzato G, Corona P, Ferrari B, DI Santo D, Chirici G, Lombardi F. 2011. Stand structure attributes in potential old-growth forests in the Apennines, Italy. *L'Italia Forestale e Montana/ Italian Journal of Forest and Mountain Environments.* **66**: 365–381.

Ellenbergh H. 1988. Vegetation ecology of Central Europe. Cambridge University Press, Cambridge, UK, 2 p.

Kosovo National Forest Inventory (KNFI). 2013. Prishtina 2013. 24-27.

Gavranović A, Bogdan S,Lanšćak M, Čehulić I, Ivanković M. 2013. Seed yield and morphological variations of beechnuts in four European beech (*Fagus sylvatica* L.) populations in Croatia.

Hoffman J. 1959. Zuchtbaum auswahl bei der Rotbuche in Thüringen. Forst und Jagdzeitung. **9 (4):** 177-180.

Matthews JD. 1963. Seed production and seed certification. Unasylva, 1964. **18**:104-118.

Mitchel AF. 1956. The selection of "plus" European Larch trees. Scotland Forestry. **10 (2):** 68-80.

OECD. 2013. Guidelines on the production of forest reproductive materials.

OECD. 1974. OECD scheme for the control of forest reproductive material moving in international trade. OECD, Paris. *Forestry Papers.***18:** Commonwealth Forestry Institute, Oxford.

Forshell PW. 1963. Genetics in forest practise in Sweden. Unasylva 1964, 18:119-129.

Schreiner EJ. 1963. Some suggestions for plus-tree selection and seedling seed orchards. Proceedings of the 10th Northeaster Forest Tree Improvement Conference. 53-54.