

The silvicultural field experiments of Fernelmont

(target-tree oriented silviculture in native oak stands)

1. Location



Administrative data

Owner : Fernelmont municipality
Forest service administrative unit :
Namur (Ir. P. Lemaire)
Forest manager : AF V. Balliez

Sites data

Région limoneuse (Loess area),
Hesbigno-brabançon territory
Elevation : 190 m
Mean annual precipitation : 792 mm
Mean annual temperature : 9.4 °C
Topography : plateau
Pedology : deep and moist silty soils
Potential vegetation : Oak & Ash

2. Context

The silvicultural field experiments of Fernelmont 1 et 2 were installed in even-aged native oak stands planted late 1986 (Fernelmont 1) and 1990 (Fernelmont 2) at relatively high density : respectively 2500 seedlings/ha and 5000 seedlings/ha.

These experiments were designed to compare different initial candidate-trees (CT) density and to assess the optimal final target-trees (TT) density in the context of a dynamic tree-oriented forestry. We are thus testing a very early candidate trees selection followed by strong and regular tree-oriented thinning to maximize individual tree growth and quickly produce harvestable target-trees. In order to compensate for the very short compression phase, target-trees have been pruned.

3. Experimental design

These two field experiment are respectively composed of three 0.24 ha plots (3801, 3802, 3803) in Fernelmont 1 and one 0.5 ha plot (3804) in Fernelmont 2 (1 ha = 10 000 m²). Different candidate-trees selection density and corresponding silvicultural scenarios have been tested in these plots in order to compare their effect on the stands and assess the potential value of early candidate trees preselection. The applied thinning methodology (free-thinning) is identical in all plots and ensure free growth for target-trees : all adjacent trees that touch the crown of selected trees are cut at regular interval depending on the trees crown growth rate.



Plot 3801 : Selection of 50 target-trees/ha.

Target-trees were directly selected before the first thinning (no preselection). Pruning and thinning are regularly applied to shape the target-trees and maintain them in free growth for as long as possible. This solution is the cheaper but with the highest risk : wrong selection, wound, mortality,...



Plot 3802 : Preselection of 100 candidate-trees/ha, final selection of 50 target-trees/ha before third free-thinning.

The target-trees were selected from twice as much early preselected candidate-trees. This solution is more expensive (2 times more pruning and thinning) but we expect it to yield better overall target-trees quality .



Plot 3803 : Preselection of 200 candidate-trees/ha, final selection of 50 target-trees/ha before third free-thinning.

The target-trees were selected from four times as much early preselected candidate-trees. This solution is very expensive (4 times more pruning and thinning) but is expected to yield better quality target-trees in overall. This lead to a very low-density stands and a rapid undergrowth development.



Plot 3804 : Preselection of 100 candidate-trees/ha, final selection of 25 target-trees/ha before second free-thinning.

A low density of target-trees were selected soon after an early candidate-trees preselection. This solution intend to focus expensive silvicultural operations on perfectly shaped trees that perform very well in free growth. A conventional management of the intermediate stand may be considered.

4. Management protocol

An early preselection of the candidate-trees was done as soon as the stands reached 10 meters top-height (14 years since planting). Free-thinning was then regularly (every 3-4 year) carried out around all the selected trees to remove all their competitors. The final target-trees selection was respectively done at 14.5 meters top-height (21 years since planting) in Fernelmont 1 and at 13 meters top-height (18 years since planting) in Fernelmont 2. The silvicultural field experiment of Fernelmont 1 and 2 have been closely monitored for 24 and 20 years, 7 free-thinning have already been executed in Fernelmont 1 and 5 in Fernelmont 2.

Silvicultural treatments schedule

Table 1. Timetable of the silvicultural operations already applied in Fernelmont 1.

Years (autumn)	Age	Top height	Silvicultural treatment
1986	Planting		Plantation (2 by 2 m spacing) with plastic sheeting protection
			Weeding x 2
			Pre-commercial thinning
2000	14 yrs	10 m	Preselection of the candidate-trees (50, 100, 200 trees/ha) First free-thinning and formative pruning of the selected trees
2004	18 yrs	12.5 m	Second free-thinning and crown canopy lifting to ± 6 m
2007	21 yrs	14.5 m	Final selection of the target-trees (50 trees/ha) Third free thinning and further crown canopy lifting
2011	25 yrs	16 m	Fourth free-thinning
2014	28 yrs	18.5 m	Fifth free-thinning
2017	31 yrs		Sixth free-thinning (data currently missing)
2020	34 yrs	20.5 m	Seventh free-thinning

Table 2. Timetable of the silvicultural operations already applied in Fernelmont 2.

Years (autumn)	Age	Top height	Silvicultural treatment
1990	Planting		Plantation (1 by 2 m spacing) with plastic sheeting protection
			Weeding x 2
			Pre-commercial thinning
2004	14 yrs	10.5 m	Preselection of the candidate trees (100 trees/ha) First free-thinning and formative pruning of the selected trees
2008	18 yrs	13 m	Final selection of the target-trees (25 trees/ha) Second free-thinning and crown canopy lifting to ± 6 m
2011	21 yrs	15 m	Third free-thinning and further crown canopy lifting
2014	24 yrs	17 m	Fourth free-thinning
2017	27 yrs		Fifth free-thinning (data currently missing)
2020	30 yrs	19.5 m	Sixth free-thinning

Collected Data

The individual diameter at breast height of all trees is measured during every important silvicultural intervention (thinning), several additional data concerning total height, crown dimension and epicormic growth (see table 3) are also collected on candidate-trees and target-trees. A complete mapping of these experiments was also conducted at the beginning of the experiment and the individual position of every monitored trees is known.

Table 3. Data collected on all trees or only on selected-trees.

Collected data	All trees	Selected trees
Species	X	
Silvicultural status	X	
Girth at breast height	X	
Position	X	
Total height		X
Height to first branch		X
Crown height		X
Crown radius (in 8 directions)		X
Nearest competitor crown (in 8 directions)		X
Epicormic shoot number		X

5. Evolution of the plots and of tree growth

Table 4. Evolution of the density (N/ha) and of the total basal area (G/ha in m²/ha) in the experimental plots (post-thinning status is described on gray background).

Fernelmont 1								Fernelmont 2			
Age	Top height	3801		3802		3803		Age	Top height	3804	
		N/ha	G/ha	N/ha	G/ha	N/ha	G/ha			N/ha	G/ha
0	-	2500	-	2500	-	2500	-	0	-	5000	-
14	10	2368	14.8	2300	14.8	2279	14.2	14	10.5	2494	14.6
		1705	11.9	1713	11.9	1463	9.7			1906	12.2
18	12.5	1705	17.7	1713	18.2	1463	16	18	13	1906	18.7
		1280	14.9	1237	14.3	952	10.7			1176	13.5
21	14.5	1280	18.3	1237	18.5	952	14.9	21	15	1176	16.7
		787	12.5	761	12.5	697	11.4			990	14.5
25	16	787	16.8	761	17.3	697	16	24	17	990	17.2
		565	12.7	540	12.8	531	12.3				
28	18	565	15.2	540	15.6	531	14.8	27			
31								30	19.5	674	16.9
										582	14
34	20.5	332	13.4	336	13.6	391	15.3				
		251	9.9	272	10.9	310	11.7				

At the beginning of the experiment, the different plots (Table 4) were all characterized by similar density (N/ha) and total basal area (G/ha). The density removed by each free-thinning (thinning intensity) is directly proportional to the number of selected trees (candidate and target-trees). Thus, the highest total thinning intensity was applied in the plot 3803 (-70% N/ha after 3 free-thinning) and the lowest in the plot 3804 (-60% N/ha after 3 free-thinning). Since the final selection of 50 target-trees/ha, the total basal area after thinning appears to be stabilizing around 12.5 m²/ha (550 N/ha after fourth free-thinning) in Fernelmont 1 plots (3801 to 3803). Fernelmont 2 plot (3804) remains significantly denser with a total basal area of around 14.5 m²/ha after the third free-thinning.

Table 5. Evolution of the mean diameter at breast height (in cm) of the unselected trees (NS) and of the target-trees (TT) in the experimental plots.

Fernelmont 1							Fernelmont 2		
Age	3801		3802		3803		Age	3804	
	NS	TT	NS	TT	NS	TT		NS	TT
14	8.4	11.7	8.5	12.5	8.2	12.2	14	8.2	14.1
18	10.8	15.8	10.9	16.6	10.7	16.8	18	10.6	19.0
21	12.6	18.4	12.7	19.8	12.2	20.6	21	12.6	22.5
25	15.2	22.6	15.3	24.4	14.3	25.6	24	13.8	26.0
28	16.9	25.8	17.6	27.7	16.6	28.9	27		
31							30	16.2	32.8
34	19.3	31.8	20	34.3	18.4	35.9			

The mean annual diameter increments measured on the target trees (Table 5) remain at about 1 cm/yrs since the start of the experiment, which is unusually high for native Oak in southern Belgium. This shows that the growth potential of native oaks is heavily underestimated and that oak over 70 cm in diameter can be produced in less than a century. We hope that the continued monitoring of these experiments will show us for how long such fast growth can be maintained.

It is essential to only select good shaped trees with an excellent growth potential. Unsurprisingly, our analysis has demonstrated a strong relationship between a tree future growth and its initial size. Target-trees should therefore always be selected from the biggest flawless trees in the stand (with a dbh at least in the upper one-fourth). If such trees do not exist in the stand (or in insufficient number), such tree-oriented silviculture should probably be avoided.

6. Three-dimensional representation (generated in Capsis with the GenLoader module) of the silvicultural field experiments of Fernelmont 1 and 2

Figure 1. Crown mapping of Fernelmont 1 in 2011 during the fourth free-thinning. Unselected trees are represented in green, target-trees in red and thinned trees in gray.

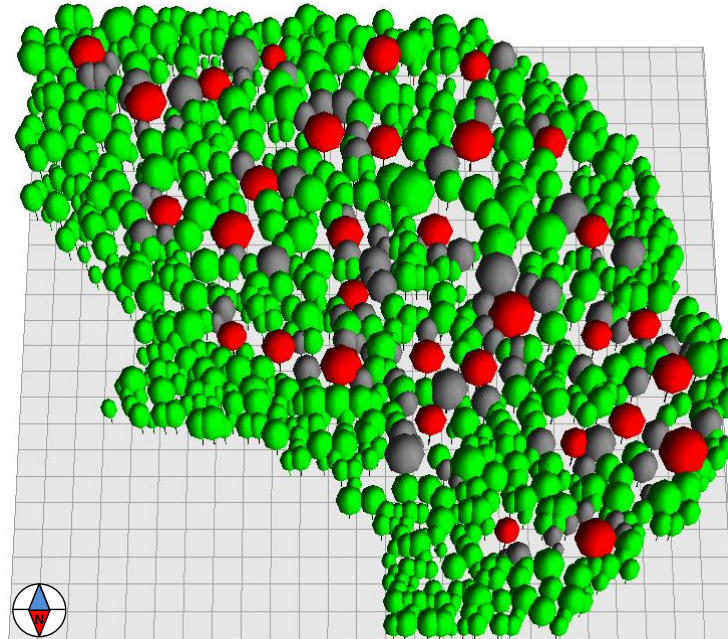


Figure 2. Crown mapping of Fernelmont 2 in 2011 during the third free-thinning. Unselected trees are represented in green, target-trees in red and thinned trees in gray.

