

Supplementary file S1 – Heights by Regeneration method and Inventory

Mean seedling height per sample plot at a given inventory i ($mean_Hi$) was analysed using linear mixed-effects models (LMER). Fixed effects included tree retention level (ret_lvl), mechanical site preparation (MSP), and their interaction. The forest stand identifier ($Stand\ ID$) and block were included as random effects ($1|StandID/Block$). This way, the model includes a random intercept for each stand and another random intercept for each block nested within its stand, reflecting the hierarchical sampling structure. Mean heights were log-transformed to improve normality and stabilise variance. P-values for fixed effects were obtained using the Satterthwaite approximation (lmerTest R package) (Kuznetsova et al. 2020). For each regeneration method separately, and each inventory time i ($1 - 5$), the R model was:

Equation 1 in R

$$\text{Log}(mean_{Hi}) \sim ret_lvl \times MSP + (1 | StandID/Block)$$

PLANTED

```
mod1_P_H <- lmer(log(mean_H1) ~ ret_lvl * Markb + (1 | BeID/Block), data = PLANTED_df)
mod2_P_H <- lmer(log(mean_H2) ~ ret_lvl * Markb + (1 | BeID/Block), data = PLANTED_df)
mod3_P_H <- lmer(log(mean_H3) ~ ret_lvl * Markb + (1 | BeID/Block), data = PLANTED_df)
mod4_P_H <- lmer(log(mean_H4) ~ ret_lvl * Markb + (1 | BeID/Block), data = PLANTED_df)
mod5_P_H <- lmer(log(mean_H5) ~ ret_lvl * Markb + (1 | BeID/Block), data = PLANTED_df)
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DIRECT SEEDED

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mod1_S_H <- lmer(log(mean_H1) ~ ret_lvl * Markb + (1 | BeID/Block), data=SEEDED_df, weights = sum_ANTAL1)
mod2_S_H <- lmer(log(mean_H2) ~ ret_lvl * Markb + (1 | BeID/Block), data=SEEDED_df, weights = sum_ANTAL2)
mod3_S_H <- lmer(log(mean_H3) ~ ret_lvl * Markb + (1 | BeID/Block), data=SEEDED_df, weights = sum_ANTAL3)
mod4_S_H <- lmer(log(mean_H4) ~ ret_lvl * Markb + (1 | BeID/Block), data=SEEDED_df, weights = sum_ANTAL4)
mod5_S_H <- lmer(log(mean_H5) ~ ret_lvl * Markb + (1 | BeID/Block), data=SEEDED_df, weights = sum_ANTAL5)
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NATURAL REGENERATION

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mod1_NR_H <- lmer(log(mean_H1) ~ ret_lvl * Markb + (1 | BeID/Block), data= NATURALR_df, weights = sum_ANTAL1)
mod2_NR_H <- lmer(log(mean_H2) ~ ret_lvl * Markb + (1 | BeID/Block), data= NATURALR_df, weights = sum_ANTAL2)
mod3_NR_H <- lmer(log(mean_H3) ~ ret_lvl * Markb + (1 | BeID/Block), data= NATURALR_df, weights = sum_ANTAL3)
mod4_NR_H <- lmer(log(mean_H4) ~ ret_lvl * Markb + (1 | BeID/Block), data= NATURALR_df, weights = sum_ANTAL4)
mod5_NR_H <- lmer(log(mean_H5) ~ ret_lvl * Markb + (1 | BeID/Block), data= NATURALR_df, weights = sum_ANTAL5)
```

For each regeneration method, and inventory time x (1 to 5) the general mathematical equation was:

General mathematical Equation 1

$$\text{log}(MeanH_{ijk}) = \beta_0 + \beta_1 \cdot ret_lvl_{ijk} + \beta_2 \cdot MSP_{ijk} + \beta_3 \cdot (ret_lvl \times MSP)_{ijk} + u_j + v_{k(j)} + \varepsilon_{ijk}$$

Where β_0 is the intercept, β_1 to β_3 are fixed effect coefficients, $u_j \sim \mathcal{N}(0, \sigma_u^2)$ is the random effect for stand, $v_{k(j)} \sim \mathcal{N}(0, \sigma_v^2)$ is the random effect for block nested within stand, and $\varepsilon_{ijk} \sim \mathcal{N}(0, \sigma^2)$ is the residual error.

Supplementary S1 Table 1. Results from ANOVA examining the effects of Retention Level, Site Preparation, and their interaction (Retention × Site) on the log-transformed mean height for the different regeneration types (*Planted Seedlings*, *Direct Seeded*, and *Naturally Regenerated*) across five inventories (H1–H5). Each cell reports the F-statistic from a Type II Wald F test, with degrees of freedom estimated using the Kenward–Roger approximation (reported as $F(\text{numerator df}, \text{denominator df})$), and the associated p-value. The response variable for each inventory is the log-transformed mean seedling height ($\log(\text{mean_H}_x)$, where $x = 1$ to 5).

Type	Factor	Inventory 1 ($\log(\text{mean_H1})$)	Inventory 2 ($\log(\text{mean_H2})$)	Inventory 3 ($\log(\text{mean_H3})$)	Inventory 4 ($\log(\text{mean_H4})$)	Inventory 5 ($\log(\text{mean_H5})$)
Planted Seedlings	Retention Level	F=0.582 (4,9.847), p=0.683	F=0.826 (4,10.121), p=0.538	F=0.855 (4,10.097), p=0.522	F=1.048 (4,10.170), p=0.430	F=1.011 (4,10.281), p=0.446
	Site Preparation	F=12.106 (1,47.893), p=0.001 **	F=29.748 (1,36.732), p<0.001 ***	F=30.193 (1,31.576), p<0.001 ***	F=45.872 (1,32.435), p<0.001 ***	F=45.959 (1,32.700), p<0.001 ***
	Retention × Site	F=0.491 (4,47.893), p=0.742	F=0.183 (4,36.732), p=0.946	F=0.293 (4,31.576), p=0.880	F=0.177 (4,32.435), p=0.949	F=0.154 (4,32.700), p=0.960
Direct Seeded	Retention Level	F=0.253 (4,16.639), p=0.904	F=0.572 (4,14.051), p=0.688	F=2.542 (4,15.369), p=0.082	F=2.376 (4,14.533), p=0.100	F=3.181 (4,15.340), p=0.044 *
	Site Preparation	F=8.534 (1,47.507), p=0.005 **	F=9.371 (1,48.593), p=0.004 **	F=23.996 (1,37.170), p<0.001 ***	F=37.353 (1,38.194), p<0.001 ***	F=35.415 (1,38.570), p<0.001 ***
	Retention × Site	F=0.851 (4,47.648), p=0.500	F=0.547 (4,48.677), p=0.702	F=1.114 (4,37.708), p=0.364	F=1.724 (4,38.641), p=0.164	F=1.777 (4,39.106), p=0.153
Naturally Regenerated	Retention Level	F=1.645 (4,21.112), p=0.200	F=1.167 (4,13.138), p=0.370	F=1.138 (4,9.534), p=0.395	F=0.589 (4,11.336), p=0.677	F=0.218 (4,10.998), p=0.923
	Site Preparation	F=4.781 (1,31.537), p=0.036 *	F=30.734 (1,41.332), p<0.001 ***	F=23.577 (1,40.180), p<0.001 ***	F=18.228 (1,39.090), p<0.001 ***	F=11.853 (1,35.717), p=0.001 **
	Retention × Site	F=2.825 (4,34.274), p=0.040 *	F=0.574 (4,41.512), p=0.683	F=1.232 (4,39.839), p=0.313	F=2.225 (4,38.246), p=0.084 .	F=1.819 (4,35.647), p=0.147

Notes: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, . $p < 0.1$

F-values are from Type II Wald F tests with Kenward–Roger df Response variable for each inventory is indicated in parentheses.

Response variable for each inventory is the log of mean seedling height.

“Retention level” refers to the tree retention category (five levels: 3, 10, 30, 50 % or Burn 50).

“Site preparation” = mechanical site-preparation treatment (0 = without, 1 = with).

Supplementary S1 Table 2. Model estimates for the height models for each regeneration method across five inventory times. Retention level is treated as a categorical variable with five levels; therefore, all corresponding coefficients (β) and interaction terms (β) are presented. The intercept reflects the reference levels (e.g., retention level = 3%, MSP = 0). Values with $p < 0.05$ are highlighted in red to indicate statistical significance.

Method	term	Inventory 1				Inventory 2				Inventory 3				Inventory 4				Inventory 5			
		estimate	std.error	statistic	p.value	estimate	std.error	statistic	p.value	estimate	std.error	statistic	p.value	estimate	std.error	statistic	p.value	estimate	std.error	statistic	p.value
Planted	(Intercept)	3,354	0,093	35,943	0,000	3,522	0,103	34,246	0,000	3,847	0,159	24,150	0,000	4,125	0,158	26,189	0,000	4,354	0,155	28,170	0,000
	ret_lv10	0,015	0,132	0,115	0,910	-0,173	0,145	-1,187	0,255	-0,271	0,225	-1,203	0,250	-0,264	0,223	-1,187	0,256	-0,224	0,219	-1,026	0,322
	ret_lv130	-0,107	0,132	-0,811	0,429	-0,139	0,145	-0,958	0,354	-0,199	0,225	-0,882	0,393	-0,274	0,223	-1,229	0,240	-0,322	0,219	-1,475	0,162
	ret_lv150	-0,089	0,132	-0,678	0,507	-0,069	0,145	-0,474	0,643	-0,067	0,225	-0,296	0,771	-0,171	0,223	-0,765	0,457	-0,165	0,219	-0,756	0,462
	ret_lv1B50	-0,103	0,127	-0,811	0,431	-0,014	0,141	-0,098	0,923	0,060	0,220	0,272	0,790	0,052	0,218	0,237	0,816	0,027	0,213	0,126	0,902
	Markb1	0,169	0,087	1,952	0,057	0,209	0,079	2,641	0,012	0,333	0,113	2,946	0,006	0,351	0,111	3,173	0,003	0,325	0,117	2,778	0,009
	ret_lv10:Markb1	-0,099	0,123	-0,807	0,424	-0,060	0,112	-0,540	0,593	-0,030	0,160	-0,187	0,853	0,021	0,156	0,134	0,895	0,050	0,165	0,303	0,764
	ret_lv130:Markb1	-0,060	0,123	-0,493	0,624	-0,014	0,112	-0,129	0,898	-0,077	0,160	-0,485	0,631	-0,042	0,156	-0,270	0,789	0,045	0,165	0,270	0,788
	ret_lv150:Markb1	-0,106	0,123	-0,863	0,392	-0,071	0,112	-0,631	0,532	-0,160	0,160	-1,000	0,325	-0,096	0,156	-0,615	0,543	-0,064	0,165	-0,388	0,701
	ret_lv1B50:Markb1	0,015	0,110	0,134	0,894	-0,007	0,100	-0,069	0,946	-0,085	0,143	-0,592	0,558	-0,053	0,140	-0,377	0,708	0,009	0,148	0,064	0,949
Direct Seeding	(Intercept)	1,712	0,128	13,412	0,000	2,068	0,180	11,466	0,000	2,752	0,160	17,185	0,000	3,142	0,158	19,886	0,000	3,465	0,157	22,073	0,000
	ret_lv10	-0,139	0,198	-0,700	0,488	-0,118	0,278	-0,423	0,676	-0,374	0,251	-1,493	0,145	-0,198	0,244	-0,811	0,423	-0,166	0,247	-0,674	0,504
	ret_lv130	-0,137	0,214	-0,640	0,526	-0,248	0,282	-0,878	0,387	-0,431	0,256	-1,683	0,101	-0,549	0,248	-2,211	0,033	-0,643	0,253	-2,538	0,015
	ret_lv150	-0,096	0,210	-0,458	0,650	-0,188	0,292	-0,645	0,524	-0,282	0,252	-1,118	0,271	-0,207	0,241	-0,859	0,396	-0,259	0,240	-1,075	0,289
	ret_lv1B50	-0,011	0,209	-0,053	0,958	-0,079	0,276	-0,288	0,776	0,023	0,249	0,091	0,928	-0,076	0,240	-0,316	0,754	-0,085	0,244	-0,348	0,730
	Markb1	0,150	0,114	1,314	0,195	0,273	0,135	2,025	0,048	0,447	0,136	3,294	0,002	0,488	0,138	3,530	0,001	0,522	0,146	3,583	0,001
	ret_lv10:Markb1	0,224	0,182	1,232	0,224	0,065	0,221	0,295	0,769	0,102	0,222	0,458	0,650	-0,024	0,221	-0,107	0,915	-0,067	0,235	-0,283	0,779
	ret_lv130:Markb1	0,196	0,198	0,987	0,329	0,106	0,226	0,470	0,640	0,083	0,228	0,362	0,719	0,235	0,225	1,042	0,304	0,293	0,241	1,214	0,232
	ret_lv150:Markb1	-0,068	0,195	-0,348	0,730	-0,257	0,240	-1,069	0,290	-0,354	0,225	-1,575	0,124	-0,390	0,218	-1,787	0,082	-0,393	0,228	-1,722	0,093
	ret_lv1B50:Markb1	-0,043	0,193	-0,221	0,826	-0,049	0,218	-0,227	0,822	-0,121	0,217	-0,555	0,582	0,019	0,214	0,087	0,931	-0,036	0,229	-0,159	0,874
Natural Regeneration	(Intercept)	3,078	0,110	27,973	0,000	3,347	0,203	16,462	0,000	3,625	0,228	15,893	0,000	3,861	0,209	18,436	0,000	3,900	0,176	22,200	0,000
	ret_lv10	0,150	0,145	1,032	0,320	-0,343	0,260	-1,317	0,208	-0,486	0,297	-1,637	0,119	-0,409	0,270	-1,515	0,145	-0,108	0,228	-0,475	0,640
	ret_lv130	0,054	0,162	0,330	0,745	0,001	0,304	0,002	0,998	0,022	0,324	0,067	0,947	-0,072	0,304	-0,237	0,814	0,060	0,262	0,230	0,820
	ret_lv150	0,062	0,187	0,328	0,745	-0,046	0,375	-0,123	0,903	-0,155	0,382	-0,406	0,687	-0,121	0,359	-0,338	0,737	0,032	0,303	0,105	0,917
	ret_lv1B50	-0,117	0,148	-0,789	0,441	-0,140	0,281	-0,497	0,624	-0,295	0,290	-1,017	0,323	-0,272	0,266	-1,025	0,317	-0,121	0,224	-0,538	0,596
	Markb1	0,624	0,336	1,859	0,071	-0,933	0,329	-2,839	0,007	-0,587	0,266	-2,203	0,033	-0,546	0,225	-2,428	0,019	-0,353	0,185	-1,906	0,063
	ret_lv10:Markb1	-1,025	0,383	-2,677	0,011	0,299	0,395	0,758	0,452	0,120	0,311	0,387	0,701	0,353	0,262	1,348	0,185	0,182	0,219	0,831	0,411
	ret_lv130:Markb1	-0,814	0,368	-2,211	0,033	0,414	0,439	0,943	0,350	-0,073	0,345	-0,210	0,835	0,051	0,305	0,166	0,869	-0,001	0,262	-0,004	0,996
	ret_lv150:Markb1	-0,352	0,415	-0,849	0,401	-0,133	0,494	-0,270	0,788	-0,100	0,410	-0,245	0,808	-0,244	0,360	-0,677	0,502	-0,265	0,305	-0,869	0,390
	ret_lv1B50:Markb1	-0,906	0,357	-2,537	0,016	0,375	0,408	0,919	0,363	0,411	0,307	1,338	0,188	0,482	0,260	1,851	0,071	0,352	0,220	1,603	0,117