

## Appendix to the final report for the project SNS 106, section 8 "Results"

### Implementation of the research plan

The project consisted of three main phases, (i) compiling a dataset on both existing data and new data from the available long-term experiments (n = 129), (ii) analyses and evaluation of data in individual experiments, and (iii) a meta-analysis of the whole data-set.

In phase (i), apart from data on tree growth and soil C/N (humus-layer) from the experiments, some other descriptive data on site (e.g. location, temperature, precipitation) and stand variables (e.g. tree species, initial stand data), as well as treatment details (e.g. dose, lime and wood ash composition) was included in the dataset.

Phase (ii) was an extensive task of the project, i.e. examine the quality of the experiments and the experimental data. This included evaluation of the experimental design, initial comparability among plots within an experiment, occurrence of damages, different methods to measure, estimate and adjust tree growth responses of the treatments and the accuracy of these estimates. Also, data on C and N in the humus layer (FH-layer) has been evaluated. In many experiments, samplings have been conducted more than once over the experimental period. The outcome of this phase was that the number of experiments used in the analyses was reduced due to e.g. calamities in some experimental stands, and missing or uncertain data. The remaining experiments (n = 119) were grouped based on, (a) the lengths of growth response periods (2 periods), (b) the "quality" of an experiment based on the relative difference in initial basal area (before treatment) between the treated plots and the control plots in an individual experiment (2 classes), and, finally, (c) the stand age at establishment (age > 0 or age > 19 years) (Table 1).

Table 1. Number of observations in different groups analysed. Bold figures relate to data presented in Figs. 1–2.

Group	Effect period 1			Effect period 12
	Lime+Ash 5–14 yrs	Lime 9–13 yrs	Ash 5–14 yrs	Lime 14–23 yrs
<i>All data</i>				
All observations	114	99	15	93
C/N <sup>1</sup> data available	99	76	15	81
<i>COMP_BA<sup>2</sup> &lt; 0.20</i>				
All observations	<b>86</b>	<b>71</b>	<b>15</b>	<b>66</b>
C/N data available	68	53	15	58
<i>COMP_BA<sup>2</sup> &lt; 0.20 and TOTAGE<sup>3</sup> &gt; 19 years</i>				
All observations	<b>65</b>	<b>50</b>	<b>15</b>	<b>46</b>
C/N data available	56	41	15	46

<sup>1</sup> C/N in the humus (FH-layer).

<sup>2</sup> COMP\_BA = |1 - (BAI<sub>treated</sub> / BAI<sub>control</sub>)|, i.e. the absolute value of the relative difference in mean basal area of the treated plots and the mean basal area of control plots within an experiment before treatment. The absolute value of COMP\_BA had to be less than 0.20.

<sup>3</sup> TOTAGE = Stand age at establishment of an experiment.

The objective of phase (iii), meta-analysis, was to correlate the relative growth response of the lime and ash treatments to the available site properties of the experimental sites. The relative growth response (RelBAI) was defined as the annual basal area increment in treated plots (BAI<sub>treated</sub>) in relation to control plots (i.e. non-lime or non-ash plots) (BAI<sub>control</sub>), [RelBAI = (BAI<sub>treated</sub> / BAI<sub>control</sub>) × 100]. The analyses included, (a) calculations of some basic data (e.g. mean, stddev), (b) correlations between all variables, (c) stepwise regression, and (d) linear regressions on the relative growth responses over site index (SI), site quality (SQ) and C/N in humus, respectively.

### Results and discussion

According to these preliminary results, there was an indicated trend in the data analysed suggesting that application of wood ash or lime may render in reduced stem growth at low-productive sites, whereas the growth seemed to be unaffected at medium-productive sites, and may be increased at

high-productive sites (Figure 1). This was for stands of *Pinus sylvestris* (L.) and *Picea abies* (L.) Karst. over a period of up to c. 15 years after application of lime and ash. Over a longer period of time (up to c. 25 years), only including limed plots, a similar or a somewhat weaker trend was indicated (Figure 2). Thus, the suggested hypothesis that the growth response of lime and ash application depends on the soil fertility, expressed as e.g. site quality, could not be rejected. However, there was a large variation around the calculated relationships with a low degree of explanation ( $R^2$ ) in most cases (Figure 1–2). Earlier indications of a similar relationship between the C/N in the FH-layer and the growth response could not be clearly shown in this study. Further data processing and analyses should be needed in order to evaluate if it is possible to reduce the variation in the data even more (e.g. tree growth responses), and possibly include some more experiments in the dataset, before more confident conclusions can be drawn.

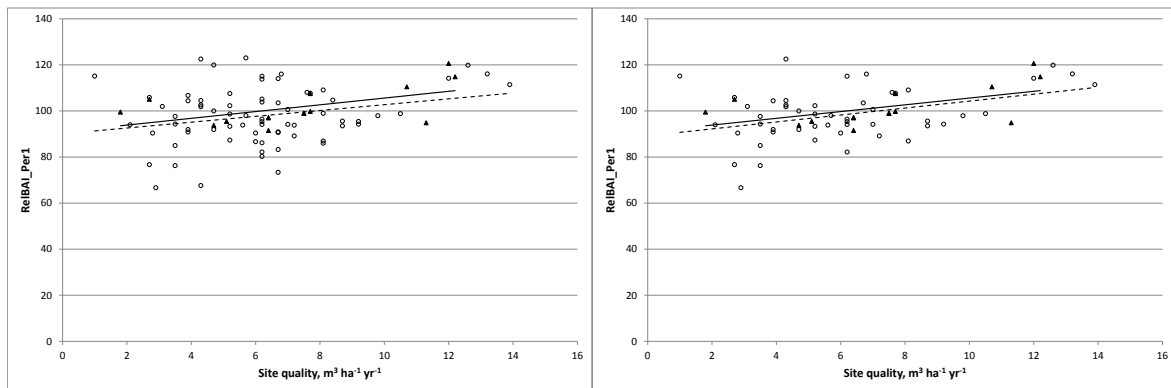


Figure 1. The relationship between site quality (SQ) and the relative basal area growth response (RelBAI\_Per1) of lime (broken line) and ash (unbroken line) over an observation period of 9–13 and 5–14 years, respectively, after treatment. Lime (○) and ash (▲) observations, when COMP\_BA < 0.20 (left), and, when (COMP\_BA < 0.20 and AgeTot > 19 years) (right). For explanation of abbreviations, see Table 1. Equations given in the figures:

- Lime (left):  $\text{RelBAI\_Per1} = 90.1 + 1.266 \times \text{SQ}$ ;  $n = 71$ ;  $R^2 = 0,07$ ;  $p_{\text{slope}} = 0.029$
- Ash (left):  $\text{RelBAI\_Per1} = 90.9 + 1.466 \times \text{SQ}$ ;  $n = 15$ ;  $R^2 = 0,31$ ;  $p_{\text{slope}} = 0.032$
- Lime (right):  $\text{RelBAI\_Per1} = 89.2 + 1.507 \times \text{SQ}$ ;  $n = 50$ ;  $R^2 = 0,15$ ;  $p_{\text{slope}} = 0.006$
- Ash (right):  $\text{RelBAI\_Per1} = 90.9 + 1.466 \times \text{SQ}$ ;  $n = 15$ ;  $R^2 = 0,31$ ;  $p_{\text{slope}} = 0.032$
- Lime+Ash (left):  $\text{RelBAI\_Per1} = 89.8 + 1.366 \times \text{SQ}$ ;  $n = 86$ ;  $R^2 = 0,09$ ;  $p_{\text{slope}} = 0.004$  (not shown in the Fig.)
- Lime+Ash (right):  $\text{RelBAI\_Per1} = 89.4 + 1.533 \times \text{SQ}$ ;  $n = 65$ ;  $R^2 = 0,18$ ;  $p_{\text{slope}} = 0.000$  (not shown in the Fig.)

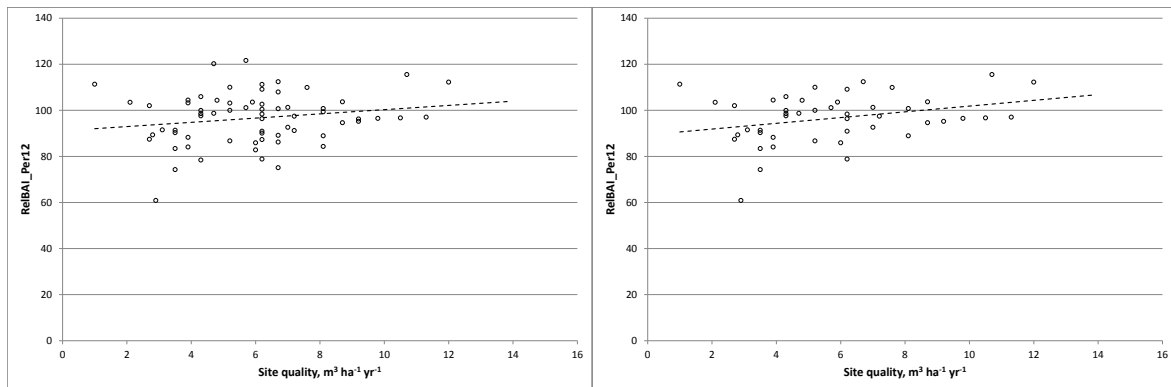


Figure 2. The relationship between site quality (SQ) and the relative basal area growth response (RelBAI\_Per12) of lime (open circles) over an observation period of 14–23 years after treatment. Lime (○) observations, when COMP\_BA < 0.20 (left), and, when (COMP\_BA < 0.20 and AgeTot > 19 years) (right). For explanation of abbreviations, see Table 1. Equations given in the figures:

- Left:  $\text{RelBAI\_Per12} = 91.1 + 0.915 \times \text{SQ}$ ;  $n = 66$ ;  $R^2 = 0,03$ ;  $p_{\text{slope}} = 0.136$
- Right:  $\text{RelBAI\_Per12} = 89.4 + 1.246 \times \text{SQ}$ ;  $n = 46$ ;  $R^2 = 0,09$ ;  $p_{\text{slope}} = 0.040$