# Inter-tree rubber yield and growth variability

## A comparison of plantations and agroforest in Sumatra - Indonesia

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## Introduction

The often-reported high variability in latex production found in agroforests has some important management consequences associated to individual tree level management decisions but it is not clear how much of this variability is of genetic origin. Therefore it is difficult to predict the extent to which the introduction of improved clonal material will effect inter-tree variability in latex production and hence associated management practices.

**Photo 1:** In line planting with regular spacing and systematic weeding lead to very homogenous plantations

**Photo 2:** Rubber agroforests are characterized by irregular planting, re-growth of secondary species, in situ regeneration of rubber seedlings leading to a much more heterogeneous tree population.

## Material and method

The experiment reported here assesses inter-tree variability in intensively managed plantations on the one hand (photo 1) where two different genetic materials are compared (GT1 seedlings and GT1 clones) and rubber agroforest planted with seedlings of uncertain origin on the other (photo 2).

The general assumption is that variance of the recorded latex productivity (or of the measured growth rate) equals to the variance due to genotype ($V_G$) + the variance due to the environment ($V_E$)+ an interaction term between genotype and environment ($V_{GxE}$) + a measurement error term ($V_{Err}$).

$$\text{Variance} = V_G+V_E+V_{GxE}+ V_{Err}$$

In this context the term "environment" stands for the biophysical environment in which trees are growing as well as the management practices and in particular the tapping regime.

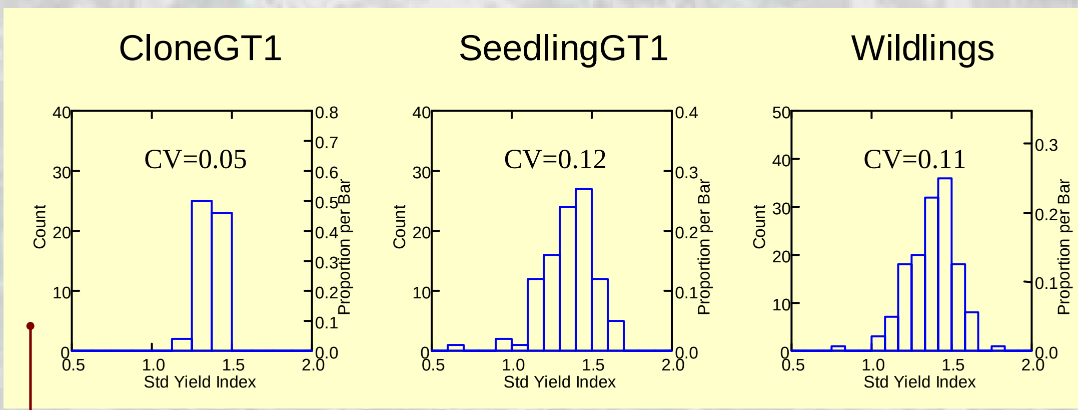


**Figure 2.** Absolute and relative frequency distribution of standardized latex yield index (see text) in a plantation (Clone GT1 and Seedlings GT1) and an agroforest (Wildlings).

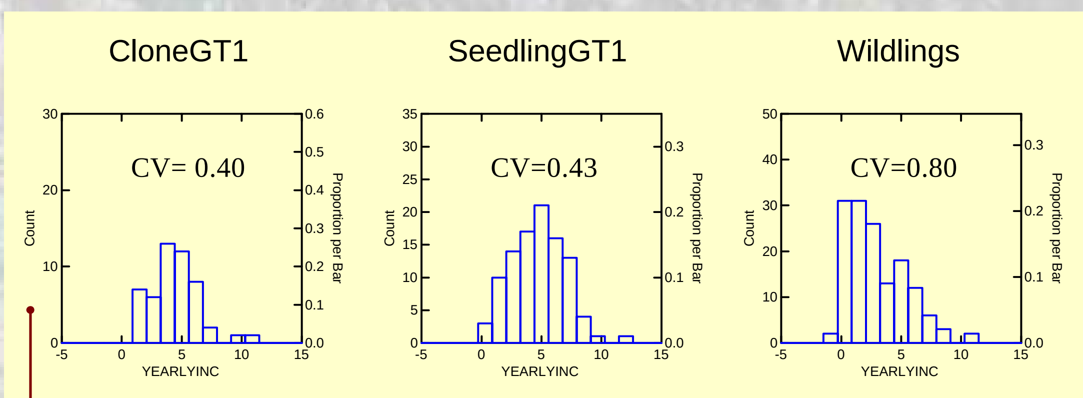


**Figure 3.** Absolute and relative frequency distribution of yearly girth increment (cm) in a plantation (Clone GT1 and seedlings GT1) and an agroforest (Wildlings).

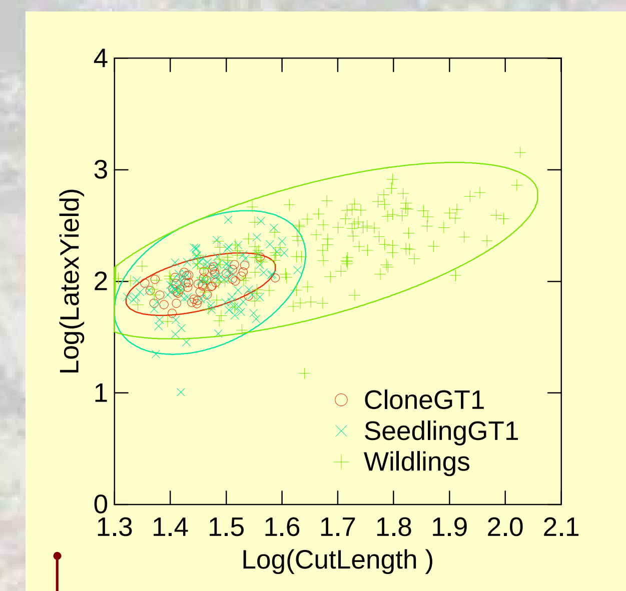


**Figure 1.** Scatter plot depicting the linear relationship after a log-log transform between the length of cut and the latex yield (overall $r^2$=0.47). Confidence ellipses based on P=0.95, the unbiased sample standard deviations of x and y determine major axes of ellipses and the sample covariance between x and y, their orientation.

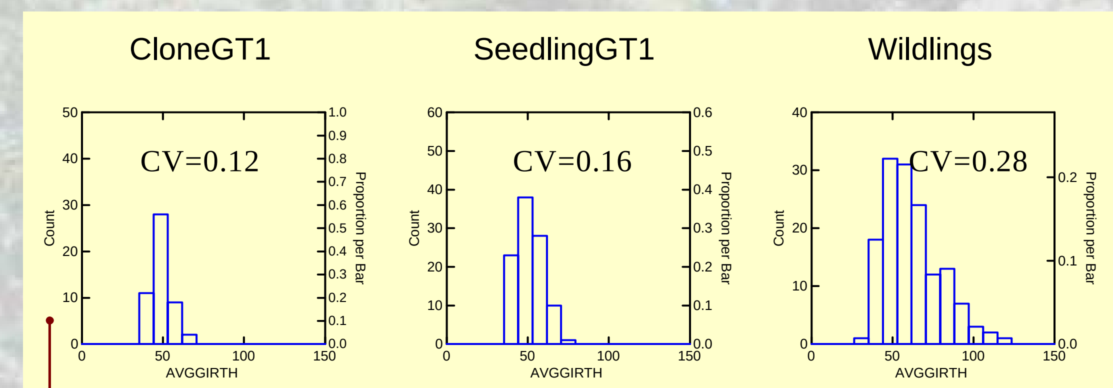


**Figure 4.** Absolute and relative frequency distribution of girth (cm) in a plantation (Clone GT1 and Seedlings GT1) and an agroforest (Wildlings).

## Results and Conclusions

Latex yield appeared to be related to the length of cut in a simple and common way across treatments. (fig.1) Therefore a standard latex production index was used instead of raw production data to compare treatments. This standard latex yield index is defined as: log(latex yield)/log(length of cut), where log stands for natural logarithm, latex yield refers to grams of dry weight of pure latex collected during a fortnight and length of cut is expressed in cm.
As expected, once corrected for length of cut the variability in latex production per tree is lowest in clonal plantation but rather surprisingly the variability in seedling plantation and agroforest is similar (fig. 2). This points at a *higher* or equal genetic variance in GT1 seedlings than in the wildlings population as the other components of the variance which are associated to the environment are certainly much higher in agroforest (uneven-aged population, irregular spacing of trees, heterogeneous competitors, irregular tapping frequency, etc).

As a matter of fact, the variation in growth rate is indeed much higher in agroforest than in plantation-like plots whether planted with seedlings or clonal material (fig. 3). This can be related to the higher environmental variability in agroforest and also probably to the higher dispersion in tree size (fig. 4). It also indicates that latex production is less sensitive to the environment variability than growth. The latex production being more conservative than growth rate suggests that allocation of resources to latex has priority over growth in rubber. This interpretation is consistent with the fact that more intensive tapping severely reduces growth and would also explain why no consistent correlation was found between growth and latex yield in this study.

From the above results is can be expected that clonal material in an agroforest will show a relatively high variability in growth rate due to the high sensitivity of growth to local environment (*sensu lato*). This will probably translate into a high variability in latex production per tree but a relatively low variability of latex corrected for length of cut since the latter appears to be quite conservative.