# Wood teak quality from plantations
# Inputs of Near-Infrared Spectroscopy tool

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*Teak (Tectona grandis) wood from natural forest is known to be highly stable and durable, but wood quality from plantation can be highly variable. Quality control of the planting material is essential to guarantee the reliability and the future of teak plantation. Near-infrared spectroscopy (NIRS), used for estimating chemical and physico-mechanical wood properties, could be a very useful tool for teak breeders for selection based on wood quality.*

## Materials and methods

Fibre saturation point (FSP) and natural durability (ND) have been measured by standard methods on teak wood samples from Togo, Ghana and Malaysia. These samples represent a large range of growth, ecology and age. The ND tests were performed using - *Antrodia* sp. - according to European standard EN 350-1. The ND classes were based on "relative loss mass" obtained after fungal attack. FSP was deduced from the regression between the dimensional (radial and tangential) variations of solid samples (1.5 x 1.5 x 1 cm) at different moisture contents.

NIR spectra were recorded on a Bruker FT-NIR spectrometer to measure diffuse reflected light from 12,500 to 4,100 $cm^{-1}$. Spectra taken from every cross-section were used in the calibration modelling. After preprocessing spectra, calibration equations were developed using partial least squares (PLS) regression based on NIR spectra and reference data. Calibrations were tested by cross- and test-validation and predicted reference data obtained by NIRS were compared to measured ones.

Table 1. Statistic data of relative mass loss and FSP for calibration sample sets and test validation set

| | Relative mass loss | | Fibre saturation point | | | |
|---|---|---|---|---|---|---|
| | Cross-validation | | Cross-validation | | Test validation | |
| | Measured | Predicted | Measured | Predicted | Measured | Predicted |
| Value | 116 | 116 | 124 | 124 | 56 | 56 |
| Mean | 0,37 | 0,38 | 20,5 | 20,5 | 20,4 | 20,3 |
| STD | 0,29 | 0,23 | 1,6 | 1,6 | 1,7 | 1,6 |
| Minimum | 0,00 | 0,00 | 17,3 | 17,6 | 17,7 | 17,8 |
| Maximum | 1,12 | 0,90 | 24,4 | 24,6 | 24,1 | 23,8 |

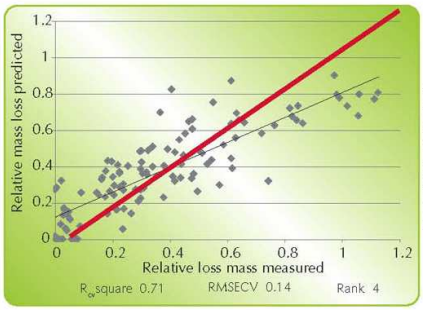


*Figure 1. Comparison relative mass loss measured vs relative mass loss predicted by cross-validation (red line: target, black line: regression)*

## Results

The reference data statistics of measured and predicted values are indicated in Table 1. Figure 1 and 2 summarize the calibration models which refer to *Antrodia* and FSP properties respectively and to longitudinal section spectra. With these regression models, we can expect a high efficiency of FSP ($R^2$=0.9) to predict unknown samples Moreover, in spite of the weak ND prediction model ($R^2$=0.7), we can use it to predict ND classes as shown by the 70% of good classification compared to measured classes (Table 2). Only neighbour errors are identified and no mismatches among samples from high and low classes were observed.

Table 2. Contingency table for natural durability classes: comparison measured vs predicted classes: yellow box: good prediction; white box: bad prediction but neighbour error; red box: very bad prediction (natural durability classes are based on relative mass loss values: class1<0.15, class2<0.3, class3<0.6, class4<0.9, class5>0.9).

| | | Predicted classes | | | | | | Bad prediction | | Good prediction | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Total | Nb | % | Nb | % |
| Measurel classes | 1 | 20 | 5 | 1 | 0 | 0 | 26 | 6 | 23 | 20 | 77 |
| | 2 | 1 | 18 | 12 | 0 | 0 | 31 | 13 | 42 | 18 | 58 |
| | 3 | 0 | 3 | 27 | 5 | 0 | 35 | 8 | 23 | 27 | 77 |
| | 4 | 0 | 0 | 3 | 13 | 0 | 16 | 3 | 19 | 13 | 81 |
| | 5 | 0 | 0 | 0 | 7 | 1 | 8 | 7 | 88 | 1 | 13 |
| Total | | 21 | 26 | 43 | 25 | 1 | 116 | 37 | 32 | 79 | 68 |

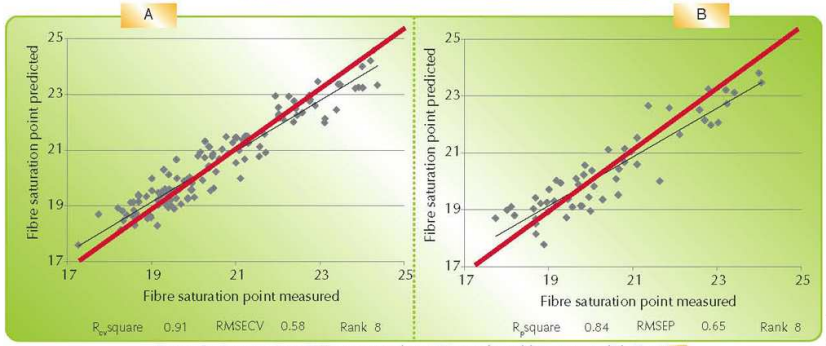


*Figure 2. Comparison FSP measured vs FSP predicted by cross-validation (A) and test validation (B) - red line: target, black line: regression*

## Conclusions

PLS calibration models based on NIRS data and standardised reference data were successfully used to predict ND and FSP properties on teak wood.

Associated with core sampling, a non destructive method, NIRS tool will allow teak geneticians to collect easily and quickly ND and FSP data on a large number of wood samples as breeding and genetics programs require.

Further work is needed to perform prediction models based on a larger sampling to improve the calibration models especially for natural durability.

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