CITES Tree Species Programme

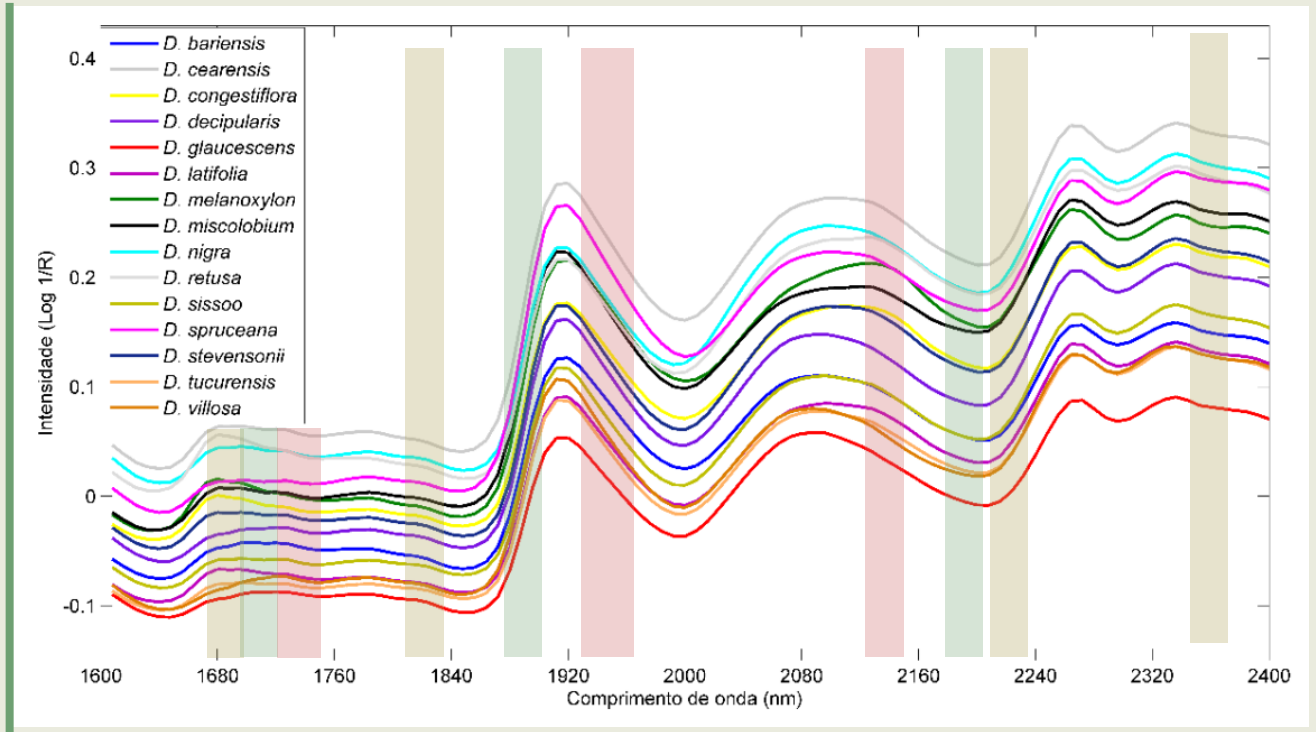
Project: CITES S608:

"Big-leaf Mahogany Provenance and Timber Identification by NIRS Technology"

Kuala Lumpur, October 05, 2022.

1. INTRODUCTION: NIR wood identification

- Minimum sample preparation.
- Fast data acquisition (~15 sec).
- **Availability of Handheld equipment (U$ 2000 to 30,000).**
- **NIR spectra contain chemical specific information:**
  - **Species identification**
  - **Origin/provenance**

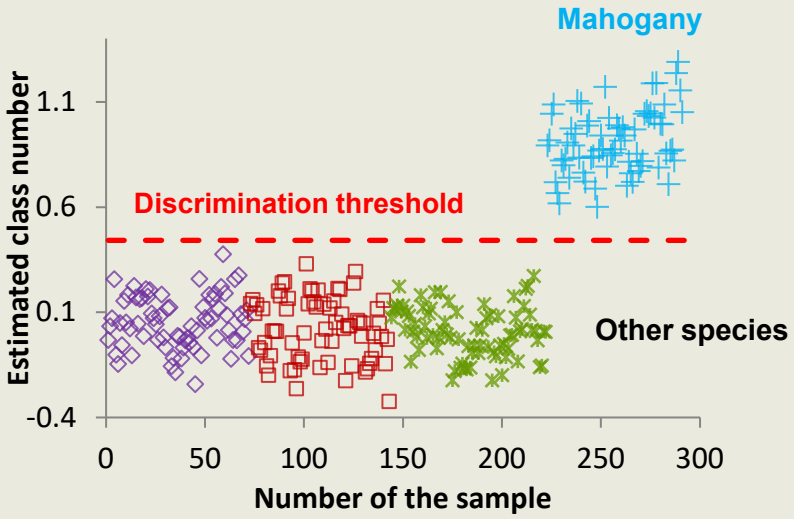


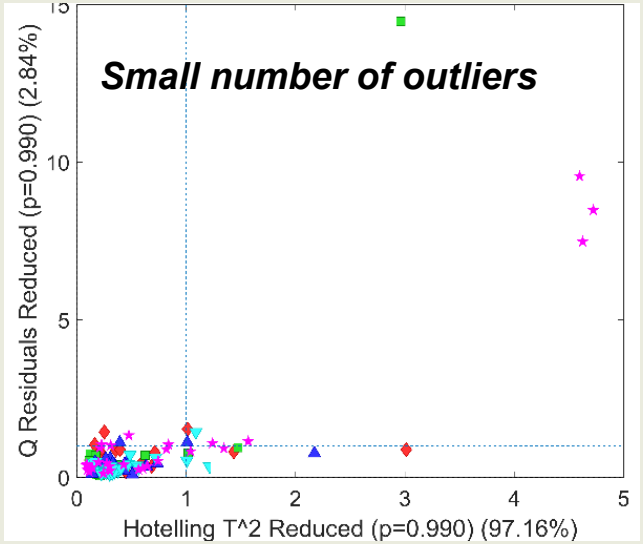
Lignin Extractives **Cellulose**

- Requires a representative number of samples of each interest species.
- Requires Chemometrics (e.g.: PLS-DA, SIMCA).
- **Requires a relative control of the moisture content of the sample.**

2. CONTEXT: NIR identification with different moisture contents

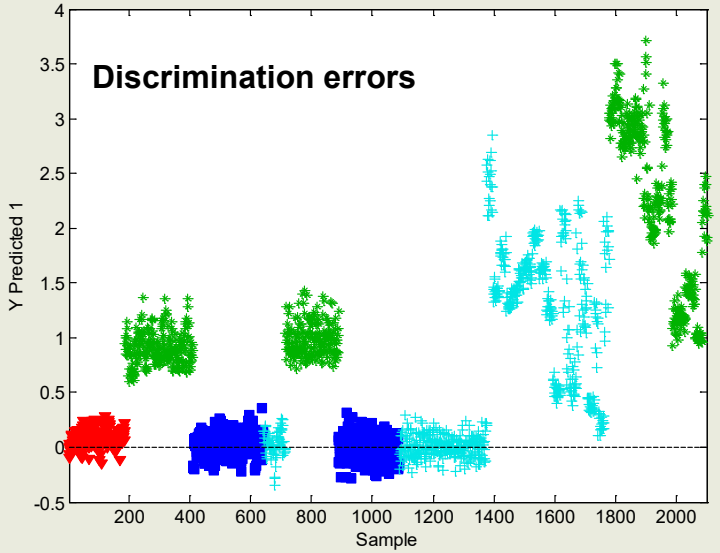
Laboratory conditions:

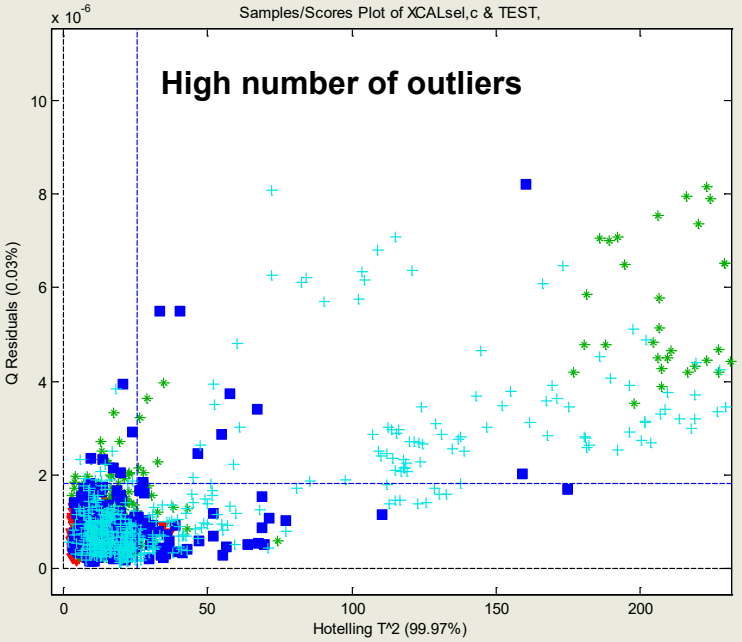




Field conditions:

- ❑ Moisture and temperature variation





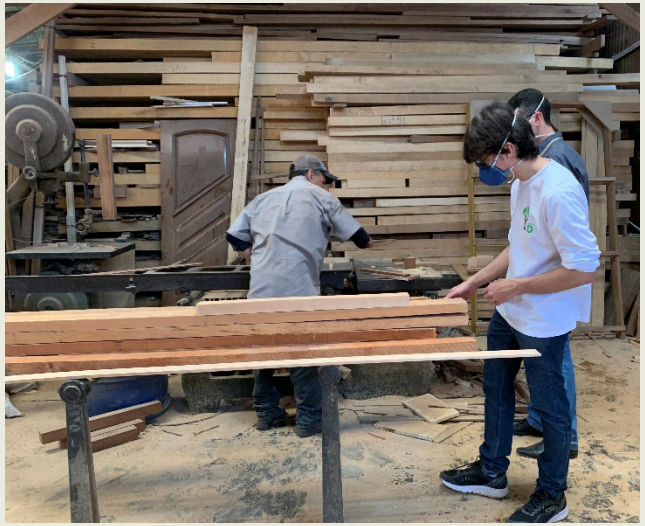
3. Current design for in situ drying and NIR analysis

EXPERIMENTAL PROCEDURE:

1) **Sanding the sample**
2) **Drying for 8 min.**
3) **Cooling the sample by applying a high volatile fluid.**
4) **Obtaining the spectra**

4.1 Results: Two missions at the JB Madeiras sawmill (Brasília/DF, Brazil) to test the new drying method.

Three species were tested: *Erisma uncinatum* (cedrinho); *Micropholis melinoniana* (curupixá) and *Cedrela odorata* (cedar).



- **Average moisture content before drying = 15 %**
- **Average moisture content after drying = 11 %**

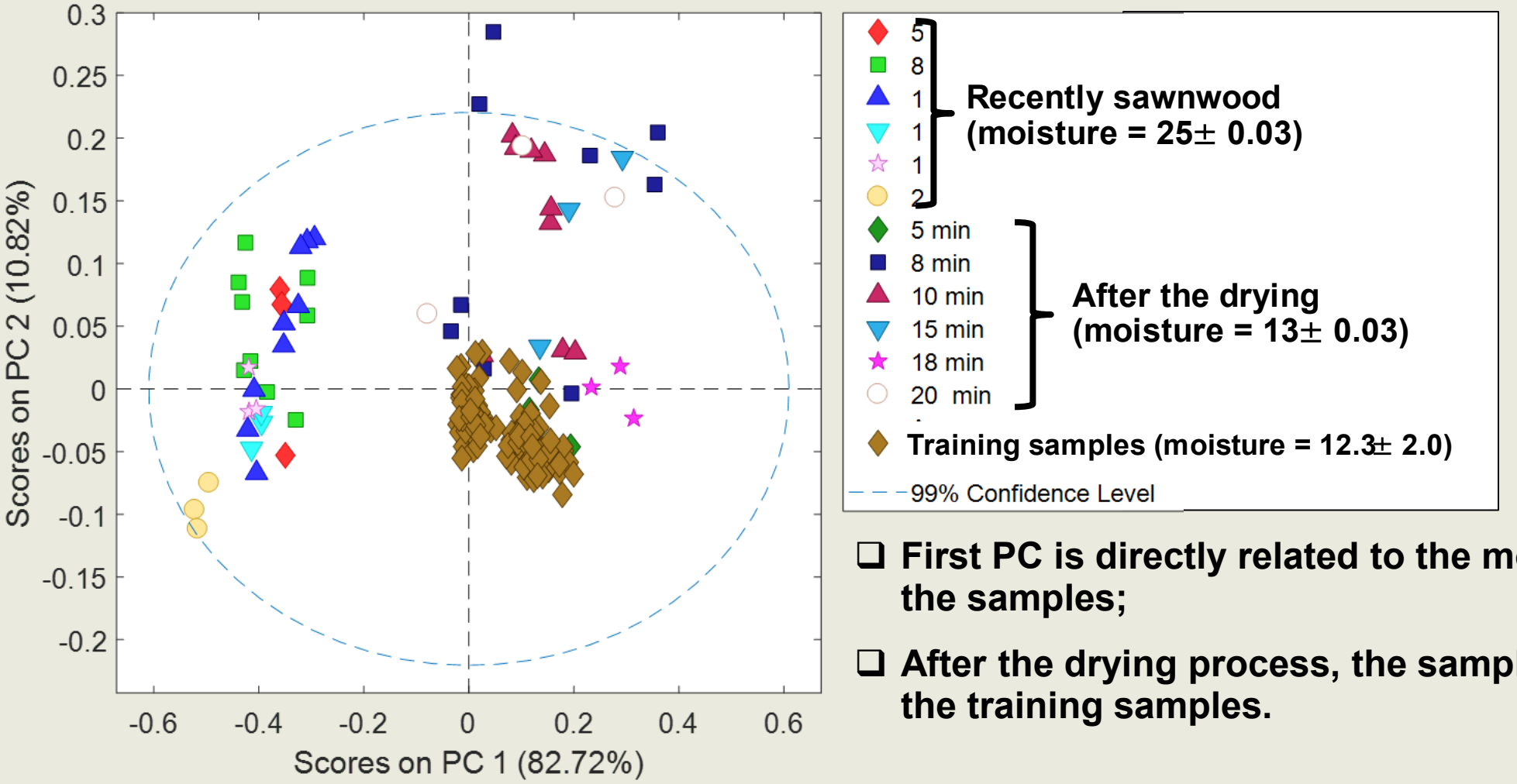
Species	Nº of samples	Nº of spectra	False positive rate	False negative rate	Efficiency Rate
Cedar	22	66	0.0 %	2.5 %	98.7 %
Cedrinho	13	39	4.1 %	15.8 %	89.9 %
Curupixá	18	54	3.4 %	0.0 %	98.3 %

- **After drying, the results presented better precision and a lower rate of errors.**

4.2 Results: mission at the Madeflona concessionaire, in Flona Jamari (Itapuã do Oeste – Rondônia state, Brazil)

NIR spectra were obtained on C. odorata boards recently sawn and after the drying method.

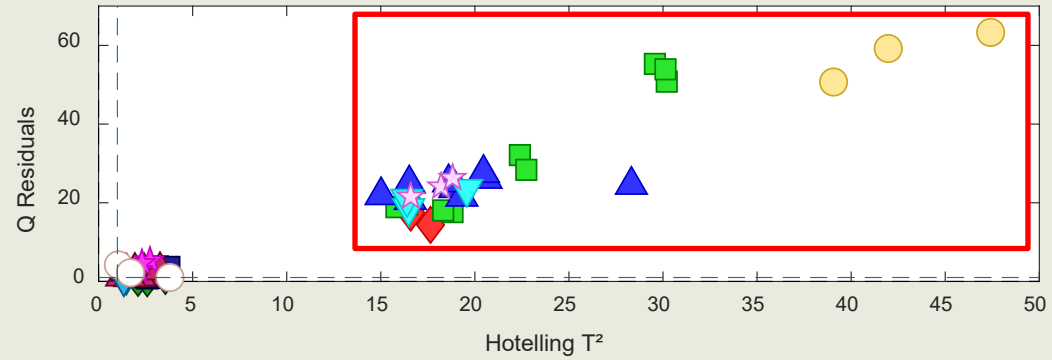
PCA results:

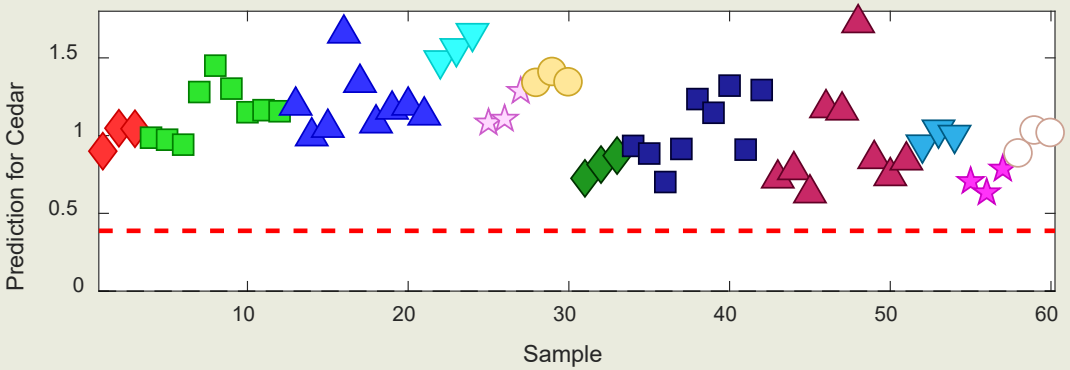


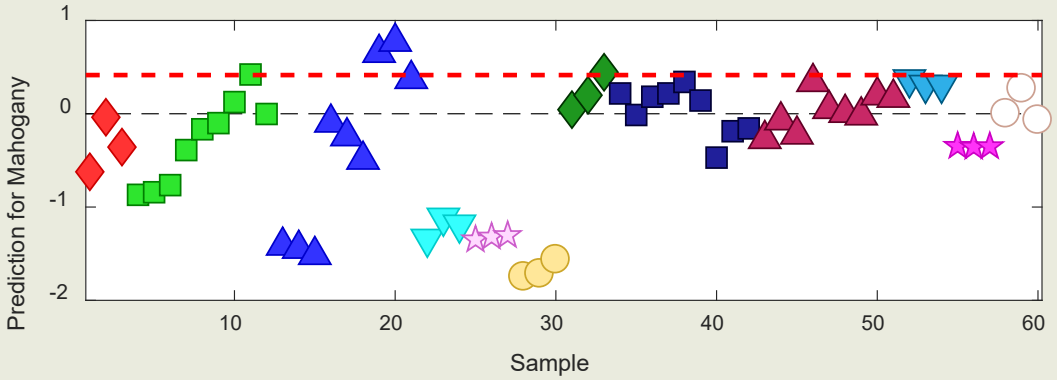
- ❑ **First PC is directly related to the moisture content in the samples;**
- ❑ **After the drying process, the samples are closer to the training samples.**

4.2 Results: mission at the Madeflona concessionaire, in Flona Jamari (Itapuã do Oeste – Rondônia state, Brazil)

Discrimination results:





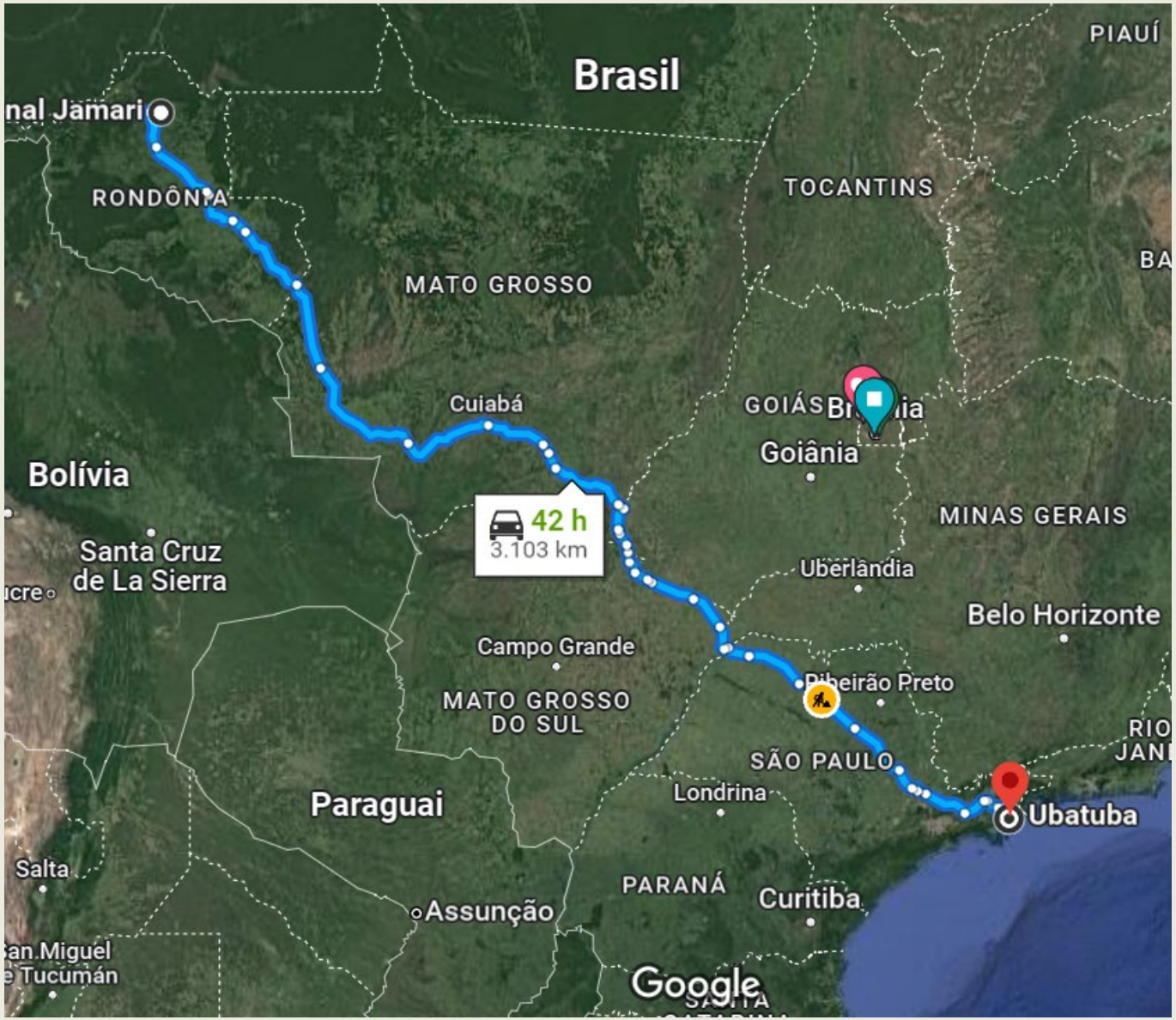


All samples before drying were outliers in the discrimination model.

	Cedar model				*Mahogany model*			
	TP	**FN**	**FNR**	**ER**	**TN**	**FP**	**FPR**	**ER**
Cedar	20	0	0%	100%	19	1	5%	95%

***TP:** true positive
FN: false negative
FNR: false negative rate
ER: efficiency rate
TN: true negative
FP: false positive
FPR: false positive rate

4.3 Cedar cargo tracking:



Aproximatelly 20 m³ of Cedar

Cargo origin:
Madeflona concessionaire, in Flona Jamari (Itapuã do Oeste – Rondônia state, Brazil)

Destination:
Ubatuba city, São Paulo State, Brazil
Distance: ~3100 km

Time between the measuring procedures: 22 days

4.3 Cedar cargo tracking: experimental procedure

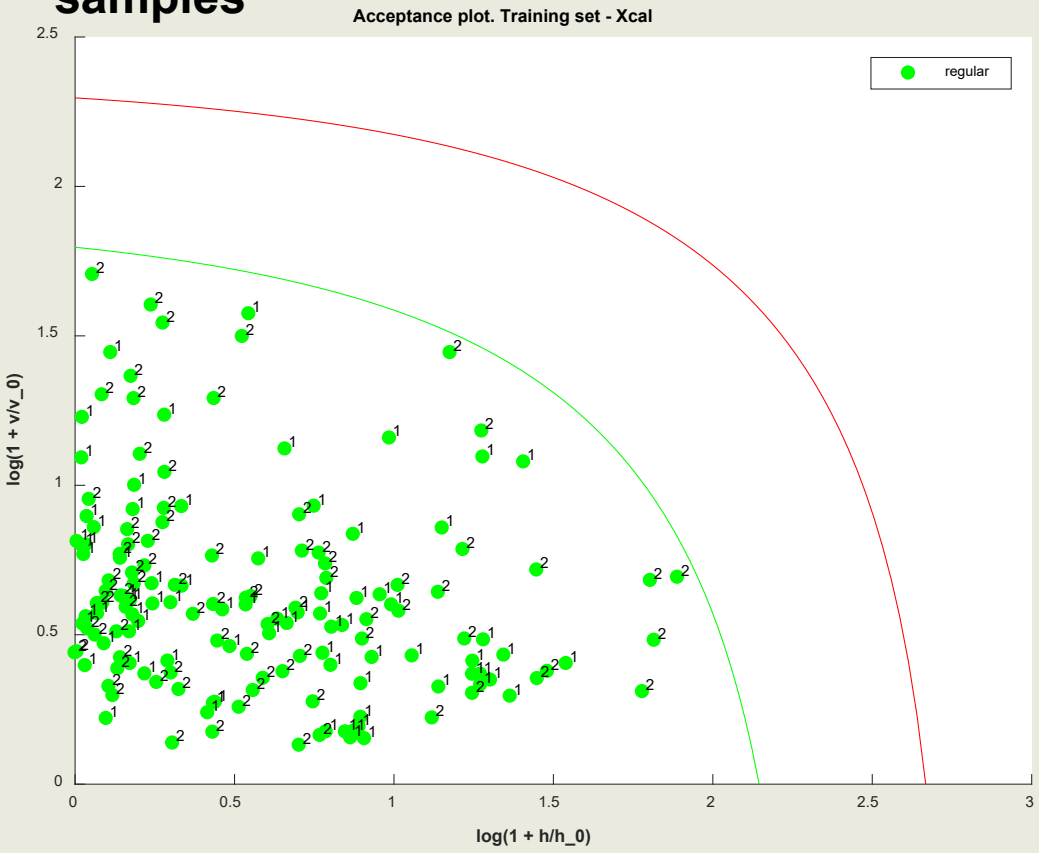
- **MEASUREMENTS AT THE ORIGIN AND FINAL DESTINATION:**
  - 7 packages
  - 6 samples per package
  - 2 different spots
  - 3 replicate spectra

- Origin: 252 spectra (126 before drying and 126 after drying).
- Final destination: 126 spectra.

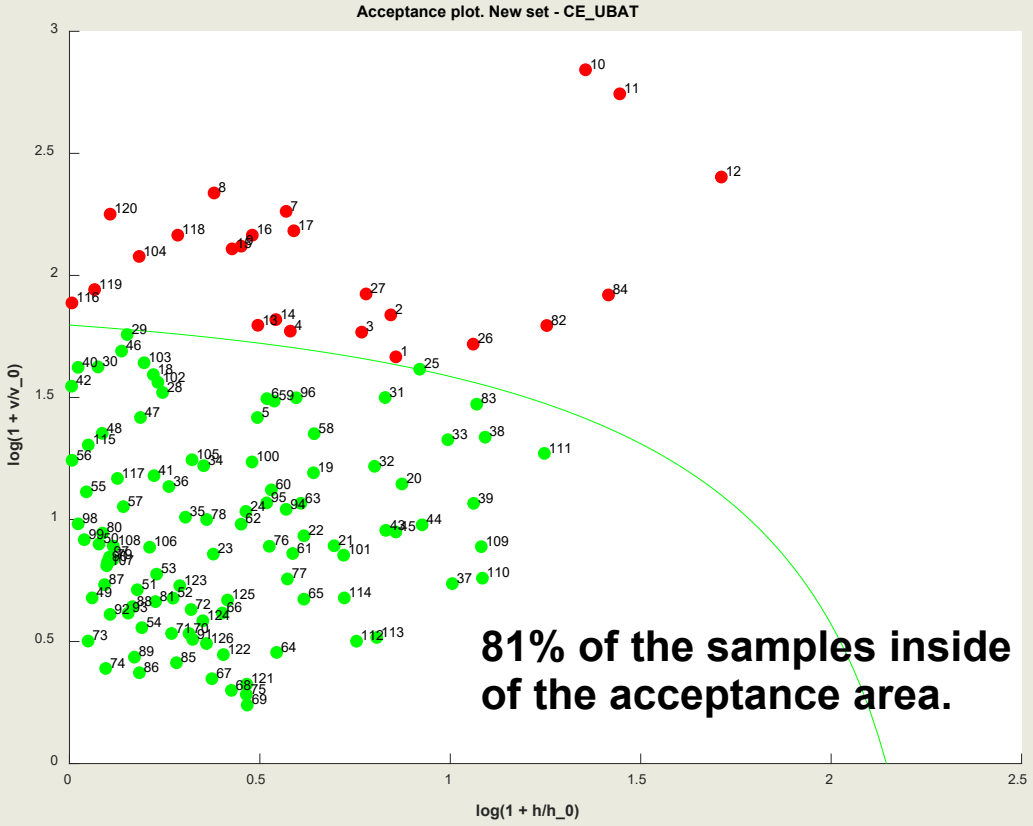
- Measurement performed at the ends of the boards.

4.3 Results: Cargo modeling by Data Driven Soft Independent Modeling of Class Analogy (DD-SIMCA)

Acceptance plot for the training samples



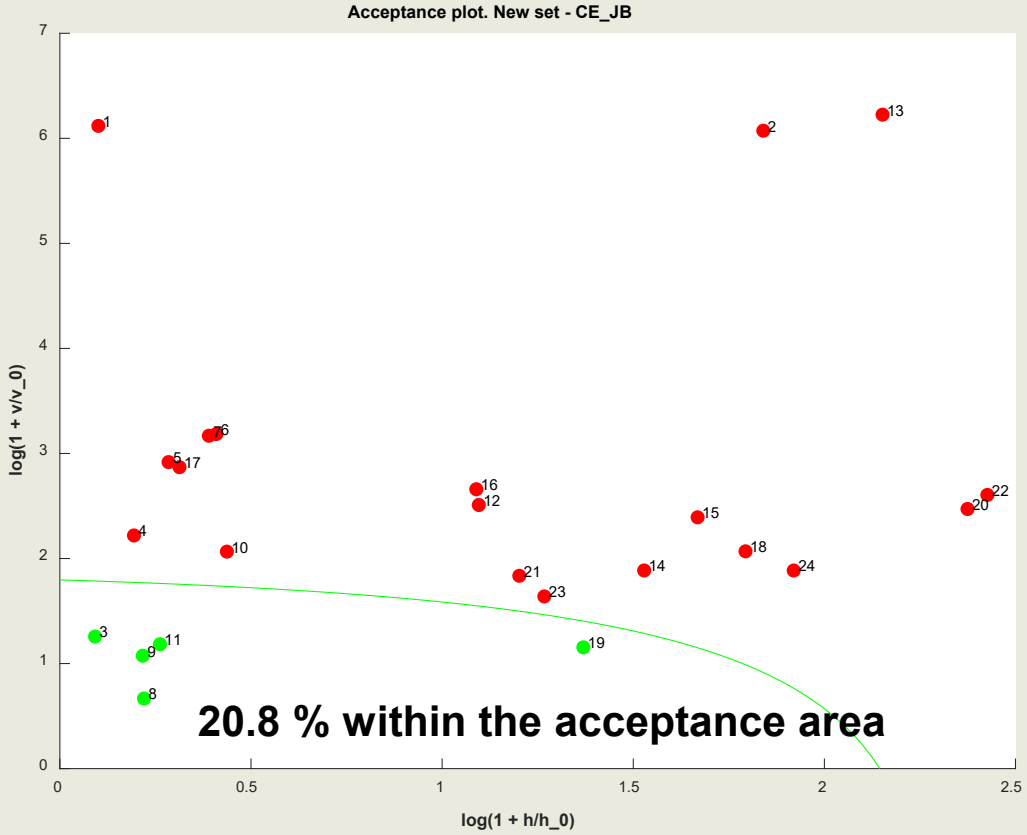
Analysis of the samples measured in Ubatuba



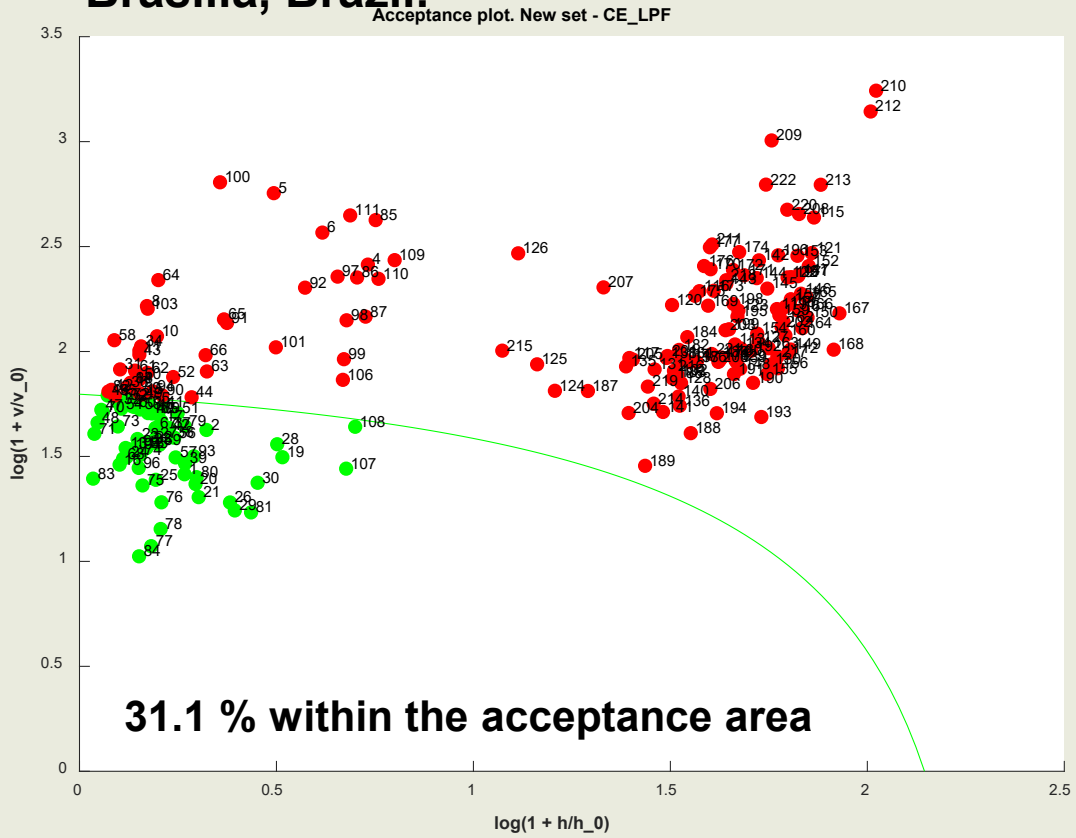
High agreement of the spectra measured of the same wood cargo in the two locations.

4.3 Results: Application of the Cedar cargo model for different samples:

Cedar samples from the JB Madeiras sawmill

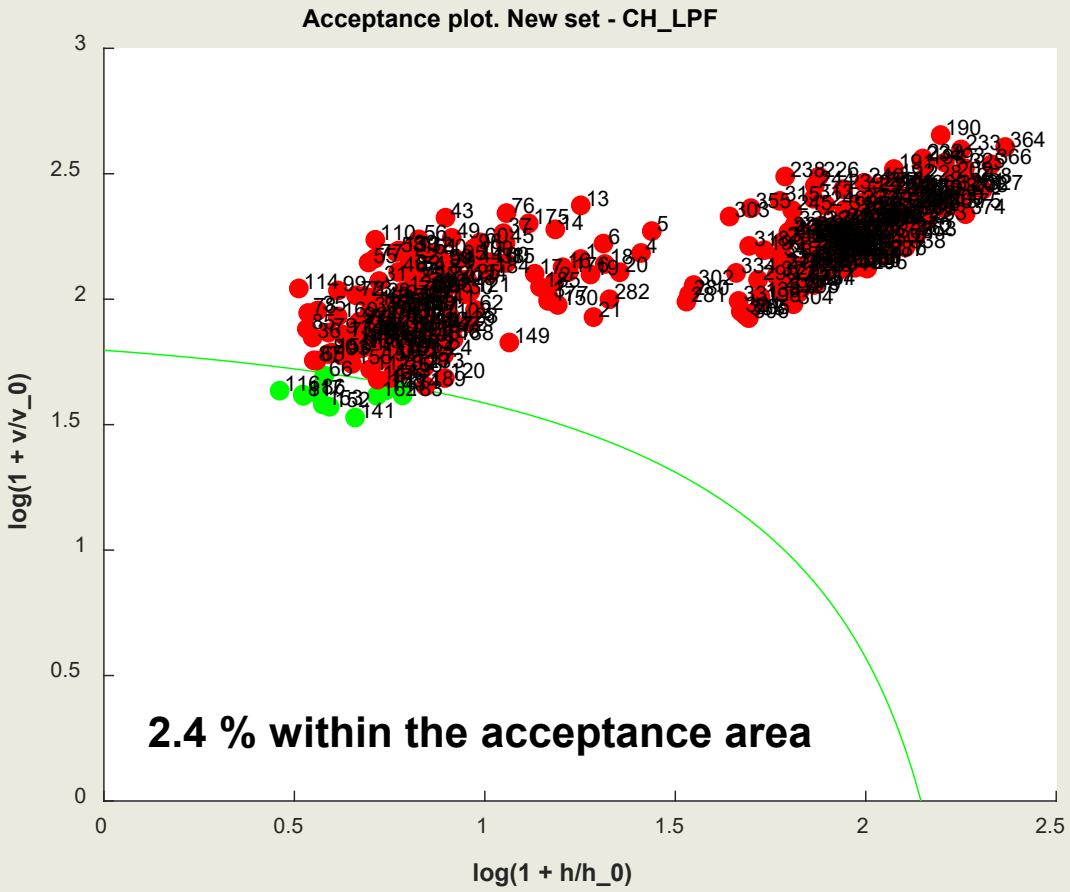


Cedar samples from the Forest Products Laboratory (LPF) wood collection in Brasilia, Brazil.

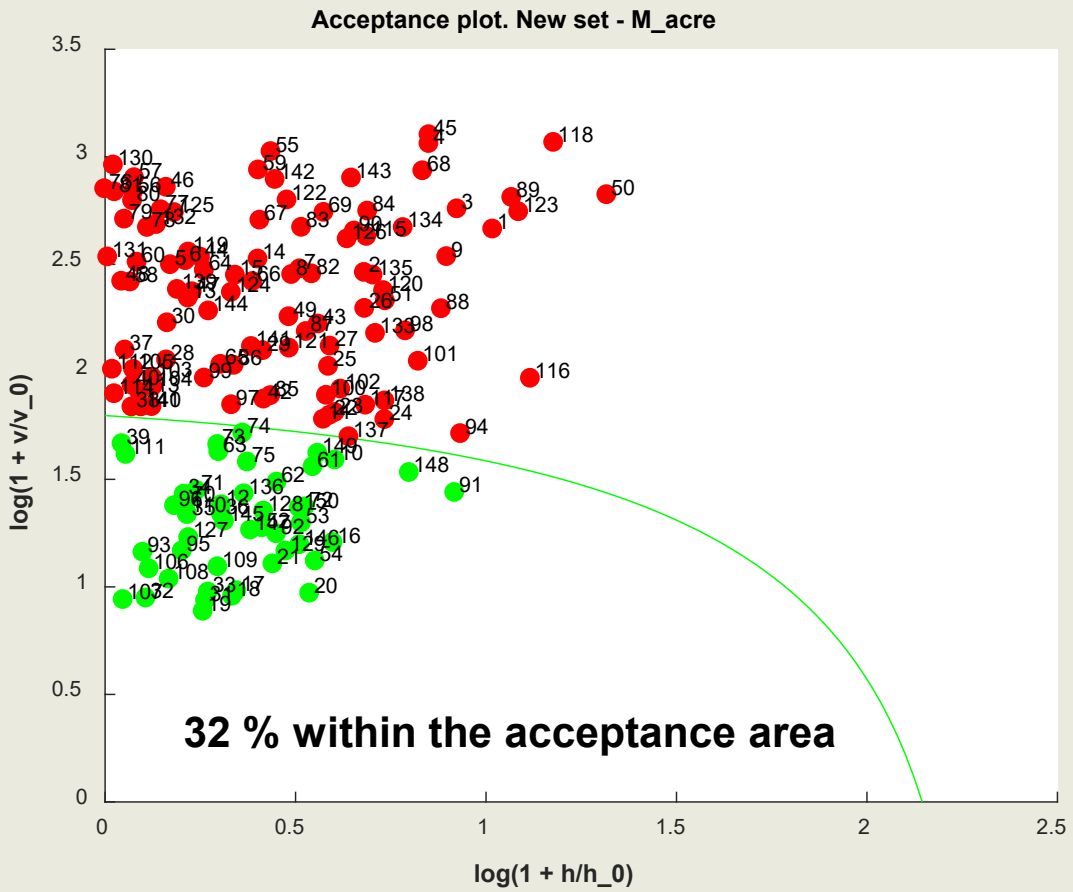


4.3 Results: Application of the Cedar cargo model for different samples:

Cedrinho samples from the LPF collection.



Mahogany samples measured at Agrocortex, Acre state, Brazil.



4.3 Results: Application of the Cedar cargo model for different samples:

Summary of results for cargo tracking:

Samples	Number of samples (spectra)	Probability of belonging to the target cargo	Conclusion
Training samples	56 (168)	**100 %**	**Belong to the cargo**
Validation samples	28 (84)	**95.2 %**	**Belong to the cargo**
Samples measured at final destination	42 (126)	**81.0%**	**Belong to the cargo**
Cedar (JB Madeiras)	12 (24)	20.8 %	Not compatible
Cedar (LPF)	37 (111)	31.1 %	Not compatible
Cedrinho (JB Madeiras)	10 (20)	25.0 %	Not compatible
Cedrinho (LPF)	63 (189)	2.4 %	Not compatible
Mahogany (Agrocortex)	24(75)	32 %	Not compatible
Mahogany (LPF)	48 (228)	20.8 %	Not compatible
Curupixá (LPF)	40 (120)	33.8 %	Not compatible

5. Conclusions:

- The proposed drying procedure is efficient and improved the results in field conditions.
- Measurements/drying are more effective at the ends of the boards
- The time for analysis increased to ~30min.
- Preliminary results indicate that the cargo tracking is possible.
- New experiments are being conducted to establish the acceptance probabilities and limitations.

Thank you for your attention!

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