



ITTO-CITES Program
for Implementing CITES Listings of Tropical Tree Species
Development and Scaling of Innovative Technologies for Wood Identification
February 28th, 2017 - Seattle USA

“Using the Near infrared (NIRS) technology as a potential tool for the monitoring of mahogany trade”

Dr. Tereza C. M. Pastore (LPF/SBF) – Project Coordinate
Prof. Dr. Jez W. B. Braga (UnB)
Dr. Vera T. R. Coradin (Researcher Associate)



PROBLEM: Identification of wood and wood's origin/provenance

Actual Solution: Wood anatomy (conventional methodology)

Alternative solutions (under development):

- ✓ ***Genetic – DNA barcoding: Alemanha, França, China**
- ✓ ***Vision machine – Image capture and comparison with a reference in the database: USA/FPL**
- ✓ **Wood anatomy using digital communication: Brazil / Instituto Florestal (SP)**
- ✓ ***NIRS – Brasil, Italy, China**

***Reference: Best Practice Guide for Forensic Timber Identification – UNODC, 2016**

NIRS MAHOGANY ID PROJECT

Specific Objectives:

- Test a successful wood identification methodology using NIRS benchtop equipment on two portable devices;
- Focus on discrimination of *Swietenia macrophylla* (mahogany) and anatomically similar wood species (*Cedrela odorata*, *Carapa guianensis*, *Micropholis melinoniana*) under field conditions;
- Discriminate *Swietenia macrophylla* wood according to the **country of origin** in America.
- Expand the spectra database to build a robust model for wood discrimination.

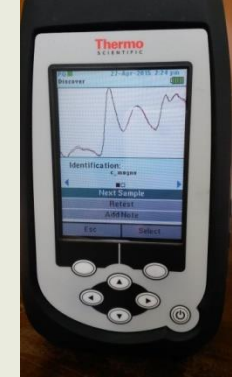
MAIN STEPS



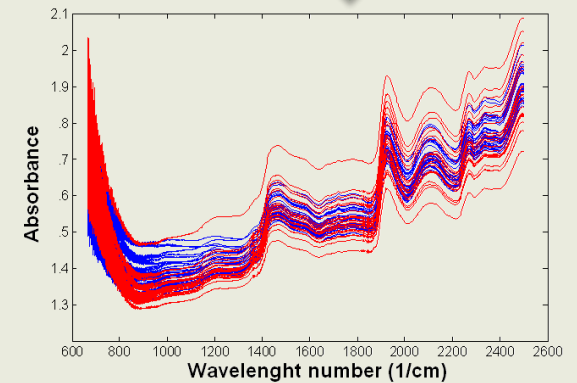
1. Wood identification



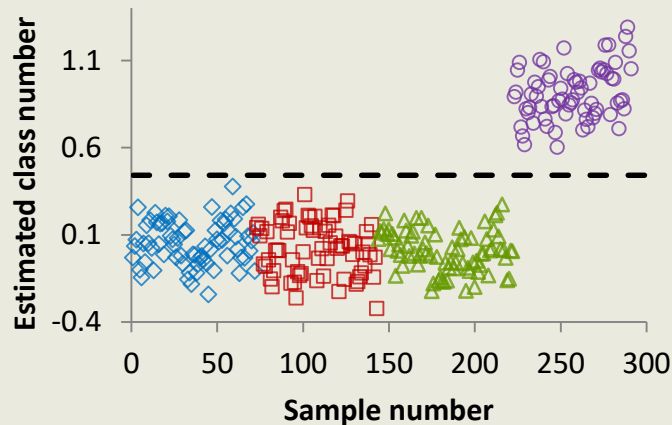
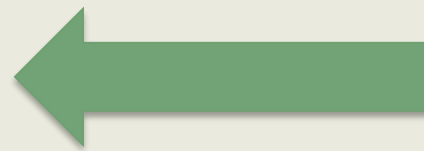
2. Surface preparation



3. NIRS spectrum obtaintion



4. Building spectra databank



6. PLS-DA model for mahogany timber identification

5. Statistical model development

PILOT MISSIONS



(1) Brazil: Brasília (DF)



(2) Brazil: Fazenda Seringal Novo Macapá (AC)



(3) Bolívia: Santa Cruz de la Sierra



(4) Guatemala: Petén

ACADEMIC CONTRIBUTIONS: 2 dissertations and 5 papers



Universidade de Brasília
Instituto de Química
Programa de Pós-Graduação em Química

DISSERTAÇÃO DE MESTRADO

Transferência de calibração na discriminação de mogno e espécies semelhantes utilizando NIRS e PLS-DA

Maria Cecília Jorge Bergo

Orientador

Prof. Dr. Jez Willian Batista Braga

Coorientadora

Dra. Tereza Cristina Monteiro Pastore

Brasília, 2014.



Universidade de Brasília
Instituto de Química
Programa de Pós-Graduação em Química

DISSERTAÇÃO DE MESTRADO

Discriminação de madeiras similares por NIRS e PLS-DA considerando variações de temperatura e umidade

Rosylane Elaine Costa Lopes

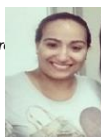
Orientador

Prof. Dr. Jez Willian Batista Braga

Coorientadora

Dra. Tereza Cristina Monteiro

Brasília, 2015.



Holzforschung, Vol. 65, pp. 73–80, 2011 • Copyright © by Walter de Gruyter • Berlin • New York. DOI 10.1515/HF.2011.010

Near infrared spectroscopy (NIRS) as a potential tool for monitoring trade of similar woods: Discrimination of true mahogany, cedar, andiroba, and curupixá

Tereza Cristina Monteiro Pastore^{1,*}, Jez Willian Batista Braga², Vera Terezinha Rauber Coradin¹, Washington Luiz Esteves Magalhães³, Esmeralda Yoshico Arakaki Okino¹, José Arlete Alves Camargos¹, Graciela Inês Bonzon de Muñiz⁴, Otávio Augusto Bressan⁴ and Fabrice Davrieux⁵

IAWA Journal, Vol. 32 (2), 2011: 285–296

THE USE OF NEAR INFRARED SPECTROSCOPY TO IDENTIFY SOLID WOOD SPECIMENS OF *SWIETENIA MACROPHYLLA* (CITES APPENDIX II)

Jez Willian Batista Braga¹, Tereza Cristina Monteiro Pastore^{2,*}, Vera Teresinha Rauber Coradin², José Arlete Alves Camargos² and Allan Ribeiro da Silva^{1, 2}

ACADEMIC CONTRIBUTIONS: 2 dissertations and 5 papers

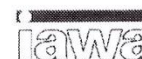
Holzforschung, Vol. 67, pp. 1–8, 2013 • Copyright © by Walter de Gruyter • Berlin • Boston. DOI 10.1515/hf-2011-0207

Assessment of total phenols and extractives of mahogany wood by near infrared spectroscopy (NIRS)

Allan Ribeiro da Silva¹, Tereza Cristina Monteiro Pastore^{2,*}, Jez Willian Batista Braga¹, Fabrice Davrieux³, Esmeralda Yoshico Arakaki Okino², Vera Teresinha Rauber Coradin², José Arlete Alves Camargos² and Alexandre Gustavo Soares do Prado



IAWA Journal 37 (3), 2016: 420–430



BRILL

NIRS IDENTIFICATION OF *SWietenia macrophylla* IS ROBUST ACROSS SPECIMENS FROM 27 COUNTRIES

Maria C.J. Bergo^{1,2}, Tereza C.M. Pastore^{2,*}, Vera T.R. Coradin², Alex C. Wiedenhoeft³, and Jez W.B. Braga¹

Quim. Nova, Vol. XY, No. 00, 1-9, 200_

<http://dx.doi.org/10.21577/0100-4042.20170014>

AValiação de Espectrômetro NIR Portátil e PLS-DA para a Discriminação de Seis Espécies Similares de Madeiras Amazônicas

Liz F. Soares^{a,b}, Diego C. da Silva^{a,b}, Maria C. J. Bergo^{a,b}, Vera T. R. Coradin^a, Jez W. B. Braga^{b,*} e Tereza C. M. Pastore^a

^aLaboratório de Produtos Florestais, Serviço Florestal Brasileiro, 70818-900 Brasília – DF, Brasil

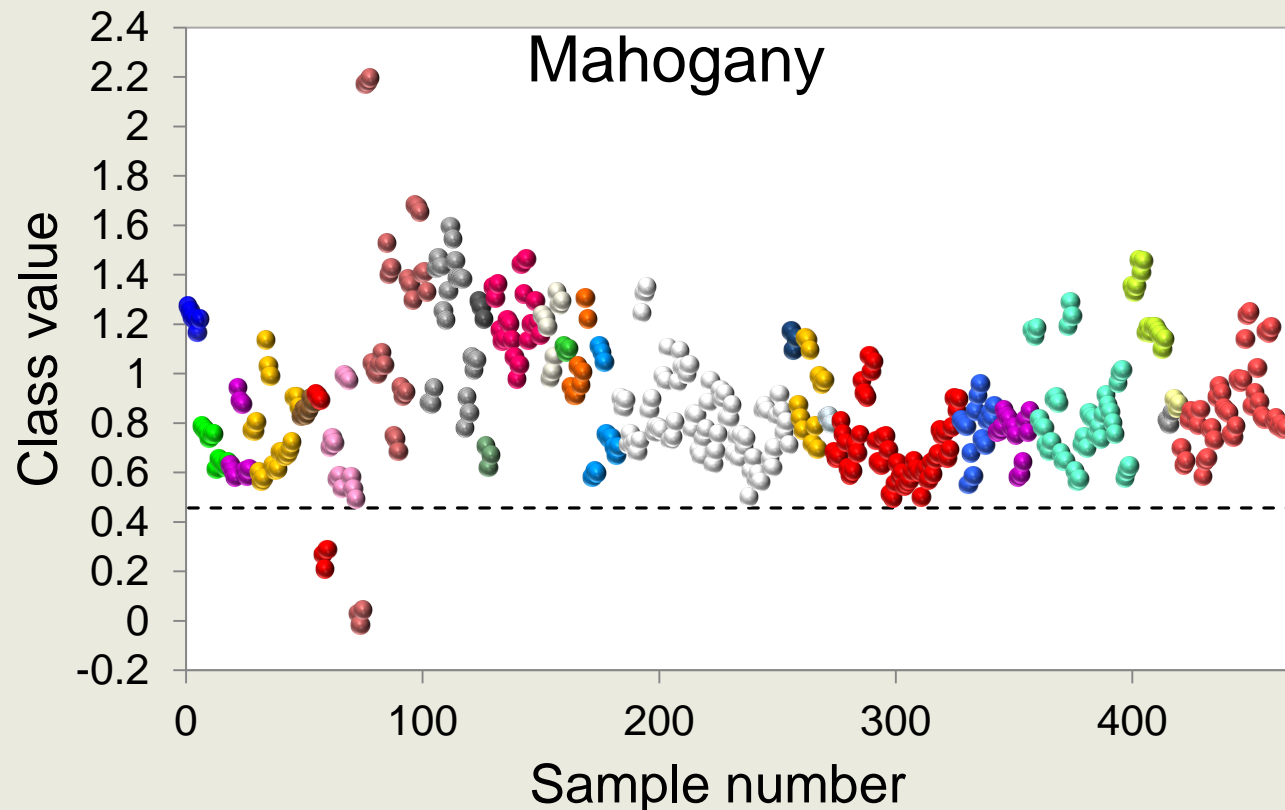
^bInstituto de Química, Universidade de Brasília, 70910-900 Brasília – DF, Brasil

RESULTS: mahogany samples from 27 countries are correctly identified

IAWA Journal 37 (3), 2016: 420–430

NIRS IDENTIFICATION OF *SWietenia macrophylla* IS ROBUST ACROSS SPECIMENS FROM 27 COUNTRIES

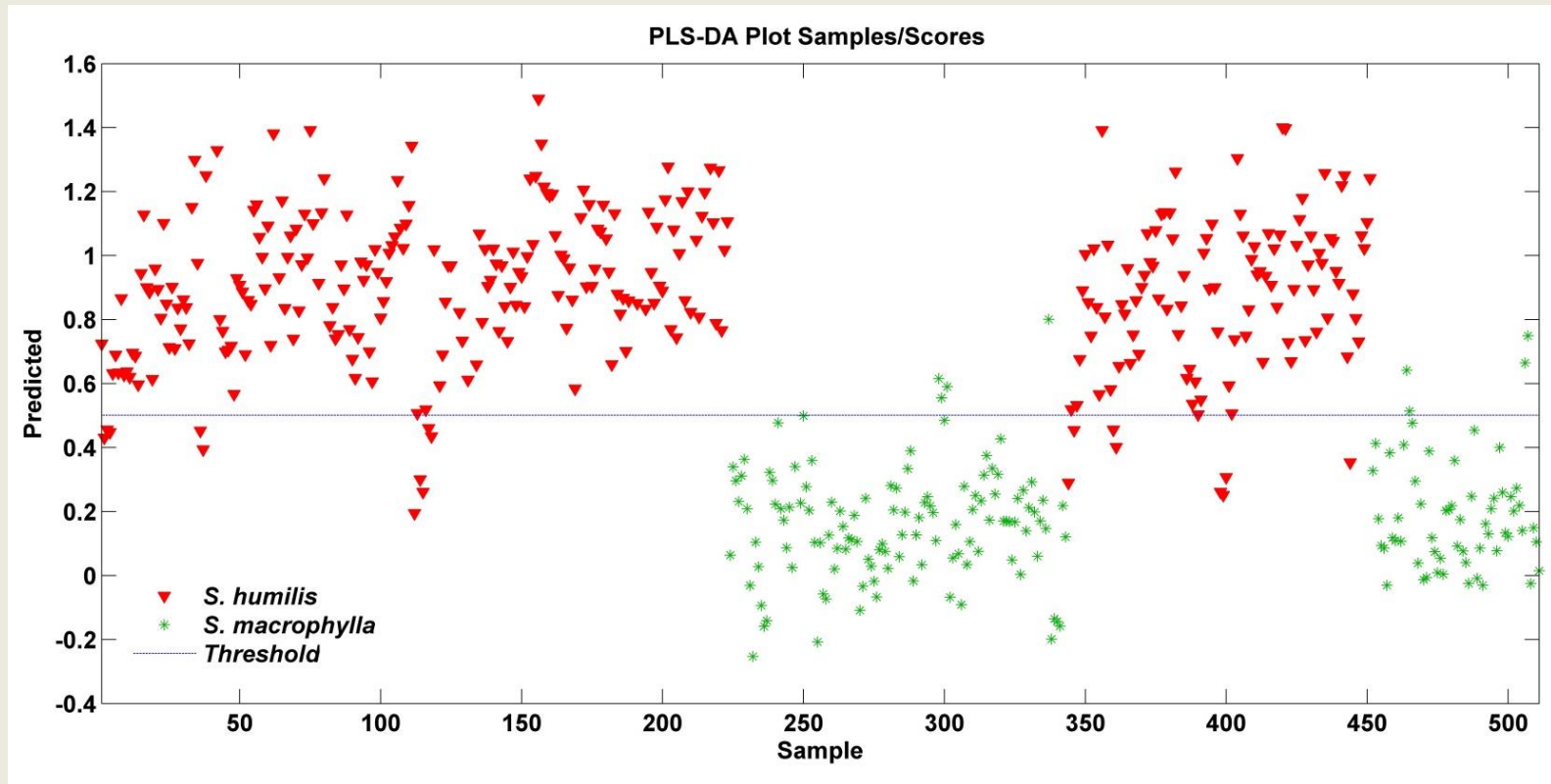
Maria C.J. Bergo^{1,2}, Tereza C.M. Pastore^{2,*}, Vera T.R. Coradin²,
Alex C. Wiedenhoeft³, and Jez W.B. Braga¹



98 % samples were classified as mahogany;

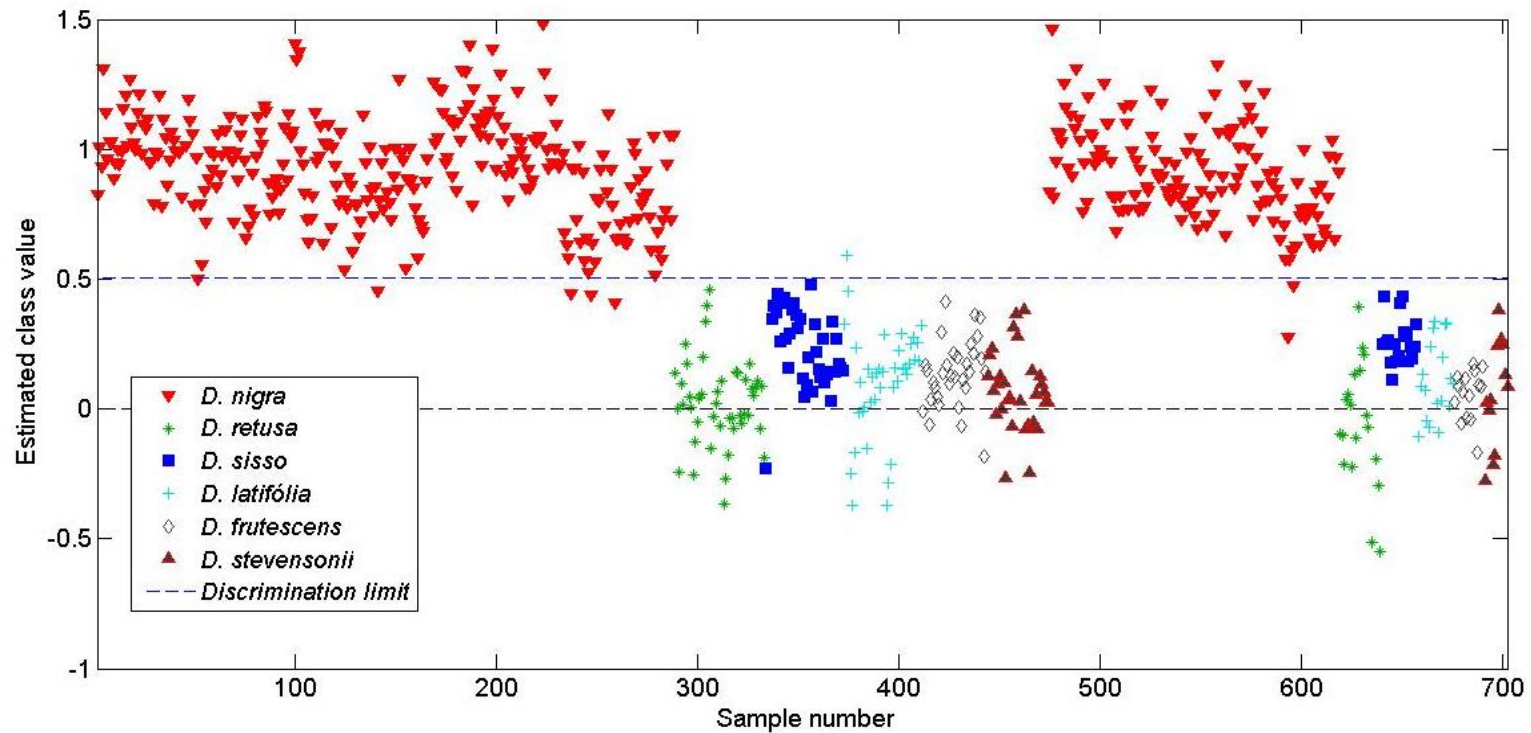


Preliminar Result: Swietenia macrophylla and S. humilis from Guatemala are discriminate



Swietenia macrophylla and *S. humilis* were separated with an Efficiency Rate of 86% .

RESULT: Discrimination between 6 *Dalbergia* species

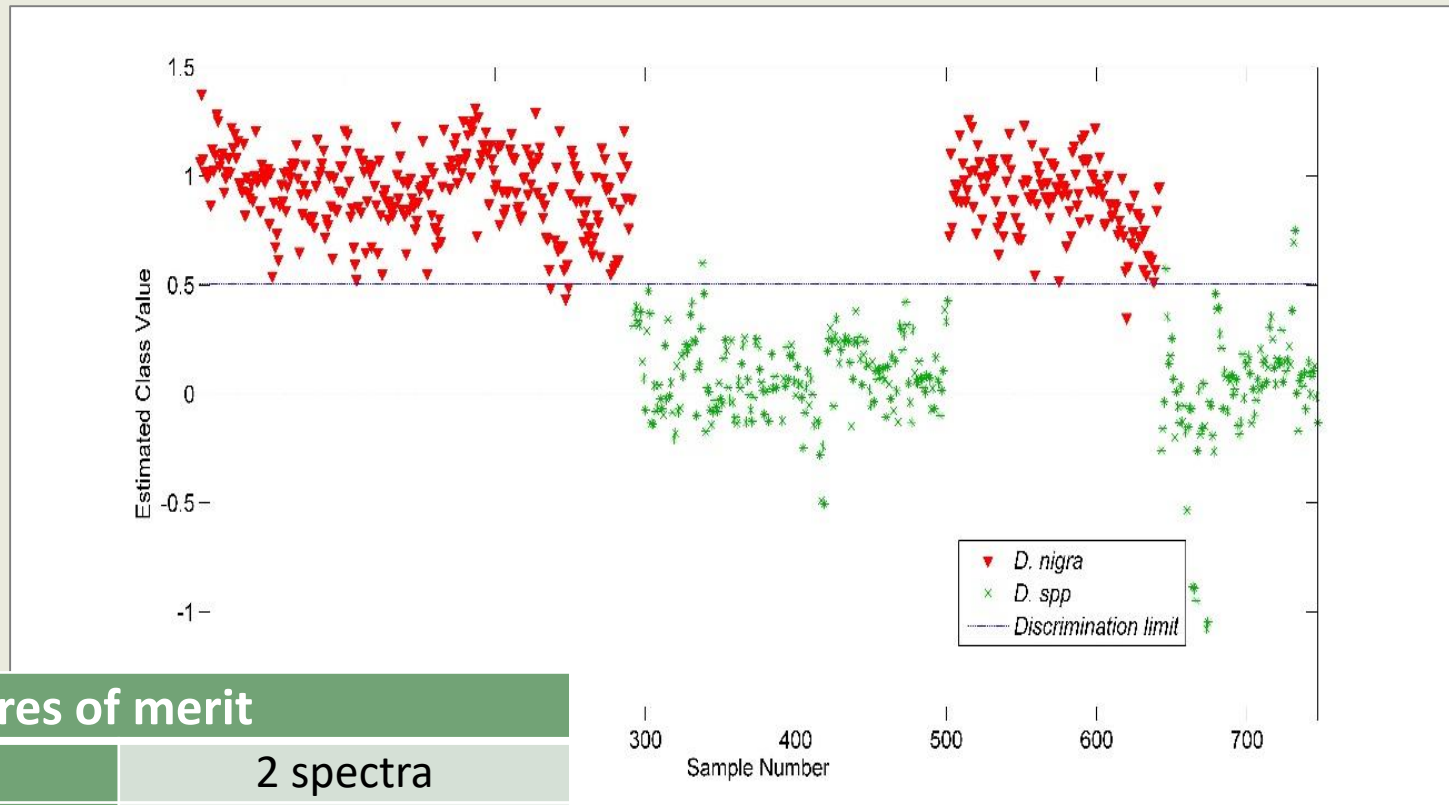


Number of samples 234

Number of spectra 702

Figures of merit	Species					
	<i>D. nigra</i>	<i>D. reutsa</i>	<i>D. sisso</i>	<i>D. latifolia</i>	<i>D. frutescens</i>	<i>D. stevensonii</i>
False Positive	0	0	5	19	5	7
False Negative	2	3	0	2	0	0
True Positive	142	14	18	16	14	12
True Negative	79	207	201	186	196	203
Efficciency Rate	98.61%	82.35%	97.57%	79.62%	97.51%	96.66%

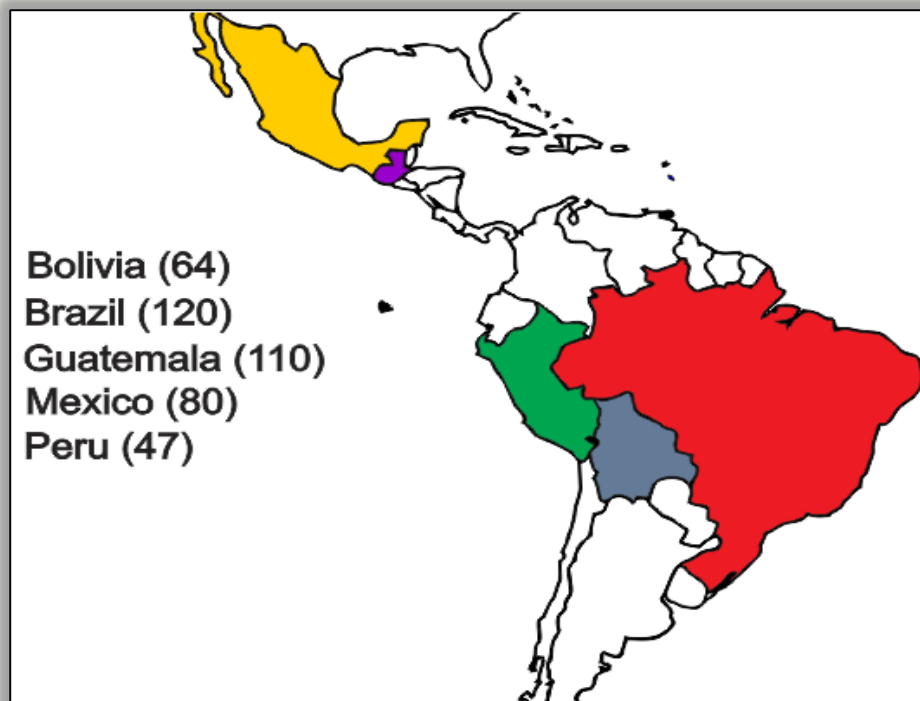
RESULT: Discrimination between *Dalbergia nigra* and 7 *Dalbergia* spp



Figures of merit

False Positive	2 spectra
False Negative	1 spectra
True Positive	140 spectra
True Negative	90 spectra
Efficiency Rate	97.12 %
Total number of samples - 249	
Total number of spectra - 747	

RESULT: identification of mahogany wood from five countries with portable device



Device	Efficiency rate (%)				
	Country				
	Bolivia	Brazil	Guatemala	Mexico	Peru
MicroNIR	99.34	90.11	100	94.87	99.37
MicroPhazir	100.00	99.43	95.90	89.36	79.26

Advantages of NIRS

1. Analyses is performed *in field* very quickly (<30s)
2. Portable devices are user-friendly and results are obtained in real time
3. Wood surface is easily prepared (plane, sand and clean)
4. NIRS is a non-destructive, reagent and waste free method



5. NIRS can distinguish wood of:
 - a) different parts of a tree: trunk, branches and fork
 - b) different species of the same family (**Meliaceae**):
mahogany, cedar and andiroba
 - a) different families:
mahogany (Meliaceae) and curupixá (Sapotaceae)
6. The comparison of costs betwen wet chemistry analysis (conventional) and NIRS is very favorable: NIRS is 2X cheaper.

Some basic requirements:

- 1. A large number of samples of each species must be available;**
 - 2. The participation of a specialized wood anatomist is essential to build a reliable model prediction;**
 - 3. The statistical model must be robust to enable a reliable discrimination of wood species;**
 - 4. Variable factors such as moisture and fiber orientation should be introduced in the chemometric model;**
 - 5. Models should be periodically reviewed and updated.**
-

CONCLUSIONS :

- **NIRS associated with multivariate analysis is a reliable method for wood identification**
- **The method can be used in field conditions with high rate of correct classification (> 90% with portable devices)**
- **It was possible to identify the geographic origin of the wood**
- **The method can be used for timber certification and illegal traffic control.**



Next steps :

- 1) consolidation of a statistic model for identification of *Swietenia macrophylla* wood geographical provenance/origin in more producer countries of Latin America;**
- 2) examine the feasibility of discrimination between *Dalbergia* genus and similar wood genus (CITES Annex II)**
- 3) expand the model for discrimination of *Dalbergia nigra* and *Dalbergia ssp*;**
- 4) examine the discrimination between *Cedrela odorata* (CITES Annex II) and *Cedrela fissilis* woods specie;**
- 5) perform an exploratory analysis of rosewood oil (CITES Annex II); and**
- 6) perform a pilot project on the front line.**

Team

Research:

Tereza C. M. Pastore (Project Coordinator– LPF/SFB)
Paulo J. P. de Fontes (Project Advisor– LPF/SFB)
Jez W. B. Braga (Chimiometrist – Instituto de Química/UnB)
Vera T. R. Coradin (Wood anatomist – Associate researcher)
José A. A. Camargos (Wood anatomist – LPF/SFB)
Alexandre B. Gontijo (Wood anatomist – LPF/SFB)
Júlia Sonsin Oliveira (Wood anatomist – IB/UnB)
Liz F. Soares (Graduated student)
Diego C. da Silva (Undergraduate student)
Nayara Guimarães (Undergraduate student)
Filipe Snel (Undergraduate student)
Pedro R. Pereira Júnior – (Undergraduate student)

Financial Management: Fundação de Tecnologia Florestal e Geoprocessamento/FUNTEC

Mônica L. Vasconcelos (Executive Director)
Angelo Santarlacci (Project Manager)
Débora G. B. S. Brito (Administrative Assistant)

Thank you very much!

tereza.pastore@florestal.gov.br

jez@unb.br

vera.coradin@gmail.com

