Improving the marketing competitiveness of Fine or Flavour cocoa origins

Project Proposal Overview

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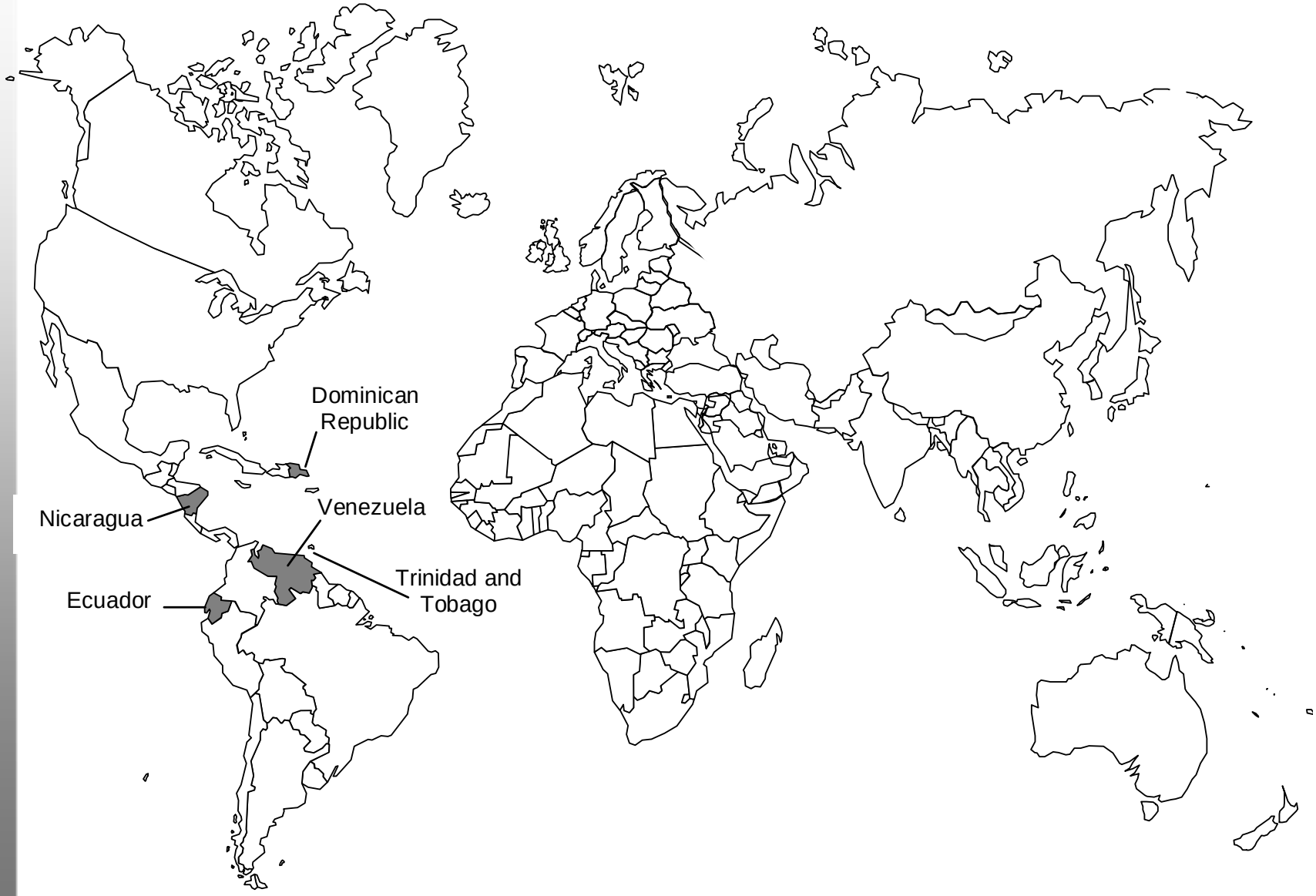
Presentation Outline

- Project Partners/Collaborators
- Rationale for the Project
  - Market forces
  - Needs/Gaps
  - Opportunities
- Overview of Project
  - Pillars, Aims & Objectives
  - Project Components
  - Component Objectives
- Project Benefits and Beneficiaries
- Application of Project Outcomes
- Budget

Project Locations



Project Partners and Collaborators

- **Partners**
  - **Dominican Republic**, Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF)
  - **Ecuador**, Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP)
  - **Nicaragua**, Laboratorio de Biociencia Universidad Nacional Autónoma de Nicaragua (UNAN)-Managua
  - **Trinidad and Tobago**, Cocoa Research Unit (CRU), The University of the West Indies - Project Executing Agency
  - **Venezuela**, Universidad del Zulia, Facultad de Agronomía
- **Collaborators**
  - Centre de coopération internationale en recherche agronomique pour le développement (CIRAD) – Technical Backstopping
  - International Cocoa Organisation (ICCO) – Supervisory Body

Rationale for Project

- **Market forces**
  - **More discriminating consumers:**
    - better quality
    - higher standards of food safety
    - origin-specific flavours
    - feel reassured by quality certification
    - traceability
  - **Concerns over physical quality:**
    - mixing different qualities and origin of cocoa
    - uncertainties about varacity of origin
    - no scientifically objective method and rapid criteria to assign grades to batches of cocoa or track quality

Rationale for Project

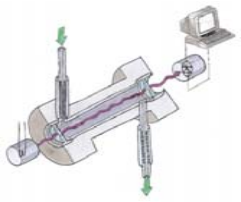
- **Needs/Gaps**
  - Application of more recent and appropriate technology and outputs from previous projects to address cocoa quality issues:
    - to regain the confidence of the international manufacturing industry
    - to devise an effective quality control system to ensure that the quality and organoleptic characteristics of export lots of cocoa are acceptable and typical of that country and traceable to specific regions.
    - to exploit the market potential of fine or flavour cocoa exports

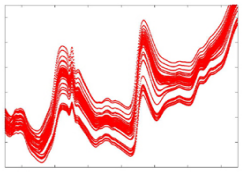
Rationale for Project

- Opportunities
  - To establish and apply Near Infrared Reflectance Spectroscopy (NIRS) technology to map the quality attributes of export grade cocoa and the various populations of cocoas from specific regions
  - Use NIRS as an innovative and rapid screening tool to identify (trace) and track cocoa quality linked to other attributes (identified from other projects)
  - Use this information to develop "Cocoa quality maps" of the main producing regions/zones in each project member country
  - Use "Cocoa quality maps" to develop and test potential criteria for "quality certification" and network sharing of information to:
    - **give an enhanced level of traceability and quality assurance to buyers**
    - **improve niche marketing opportunities for Fine or Flavor origins**

Near Infrared Reflectance Spectroscopy (NIRS)

- NIRS technology is a critical element in realising the project objectives
- Near Infrared Reflectance Spectroscopy allows for:
  - **Rapid analyses and small representative samples**
  - **Multi-criteria analyses**
  - **Possibility of carrying out qualitative and quantitative analysis**
  - **Rapid development of equations for screening products in accordance with different criteria**
  - **Adaptation to on-line quality control**
  - **Possibility of processing an unlimited number of samples**
- NIRS spectra contain relevant information about the nature, the physical characteristics and the chemical composition of the samples.
- By linking this spectral data to quantitative and qualitative data, it becomes possible to identify and authenticate the product.





Project Pillars

- Capacity Building (Human & Scientific)
- Expanded application of NIRS and use of protocols and outputs from previous projects
- Leveraging information & networking for enhanced quality & marketing opportunities

Project Aims

- Improving the capacity of fine or flavour origins to effectively measure and define key quality attributes of their specific fine or flavour cocoa types that are exported and grown in specific regions.
- Using Information about these quality attributes to improve quality monitoring at origin
- Improving the marketing competitiveness of fine or flavour cocoa exports using the quality and geographic origin information of the cocoa beans

Specific Project Objectives

1. Introduce and develop the capacity in the project member countries to conduct and apply NIRS analysis and organoleptic evaluations to establish databases with these quality profiles and other commercially important quality criteria from cocoa bean exports and cocoa varieties associated with different regions/agro-ecological zones

Specific Project Objectives

2. Develop prediction models and "Cocoa quality maps" from these databases of the main cocoa exports and cocoa producing regions/zones in each project member country to provide indices for certification and a commercially based quality control tool able to rapidly and effectively differentiate the quality and detect mixes of different cocoa qualities and genotypes

Specific Project Objectives

3. Use the project information and tools generated to formulate marketing strategies to improve the capacity of fine or flavour cocoa origins to compete in the origin specific marketplace and ultimately improve the marketing competitiveness of fine or flavour cocoa origins

Project Components

1. Introduce and develop local capacity of fine or flavour cocoa-producing countries to conduct and apply NIRS analysis for quality and origin differentiation and carry out organoleptic evaluations.

2. Create local and project wide NIRS and flavour profile databases of export grade cocoa.

3. Develop prediction models and “Cocoa Quality Maps” of the main producing regions/zones and assess indices for certification and quality control based on NIRS, flavour profiles and other cocoa quality markers (%BF and MP, Purines, aroma volatiles etc.)

4. Disseminate findings and use the information generated to formulate strategies to improve the marketing competitiveness for niche marketing.

5. Project Implementation and Management

Project Logic Flow

- NIR capacity established
- NIR and other quality databases
- Prediction models
- Tool to track cocoa quality
- Cocoa Quality Map
- Certification Indices & Quality Network
- Assessment of certification criteria
- Strategies for niche marketing

Objectives of each Project Component

- Component 1 – Objective 1
  - To **standardize protocols** for the sample collection, NIRS equipment selection, measurements and data analysis of the representative fine or flavour cocoa populations in the main producing regions/zones in the project member countries

Objectives of each Project Component

- Component 1 – Objective 2
  - To **train experts and laboratory personnel** on the criteria and practices to collect representative samples and the set up and use of NIRS equipment, analysis, database construction and interpretation of the results.

Objectives of each Project Component

- Component 1 – Objective 3
  - To **enhance the capacity** of each participating fine or flavour cocoa-producing country to prepare cocoa liquors and train tasting panels to carry out organoleptic assessments on representative cocoa bean samples, analyse and interpret sensory results.

Objectives of each Project Component

- Component 2 – Objective 1
  - To **build a robust NIRS database** in each fine or flavour cocoa-producing country using NIRS analysis**.**
- Component 2 – Objective 2
  - To **build a flavour profile database** using trained sensory panels and quality maps in each fine or flavour cocoa-producing country.

Objectives of each Project Component

- Component 3 – Objective 1
  - To **develop prediction models and "Cocoa quality maps"** from the NIRS and other quality attribute databases coupled with the optimal post harvest processing practices for cocoa from these zones in each project member

Objectives of each Project Component

- Component 3 – Objective 2
  - **Develop and test** potential criteria from the “Cocoa quality map” **for country certification indices** of the quality of the fine or flavour cocoa from a country and region within a country.

Objectives of each Project Component

- Component 4 – Objective
  - **Disseminate findings** about successful quality certification criteria and the value of the **"Cocoa quality maps"** and **"Cocoa quality network"** to assist countries to evaluate the economic value of the quality attributes for niche marketing and disseminate the project results.

- Component 5 – Objective
  - To **provide the necessary arrangements** for the coordination, supervision and implementation of all project activities.

Project Benefits

- **The specific benefits include:**
  - improved transparency and efficiency in the cocoa trade from project member countries
  - a more reliable and consistent quality for manufacturers
  - improving the quality of products and lowering costs of production
  - clear guidance for plant-breeding to obtain varieties with certain desirable characteristics
  - and a better price for the farmer delivering consistently high quality fine or flavour cocoa

Project Beneficiaries

- **Smallholder cocoa farmers** in the different cocoa producing regions communities - more stable farmer income from higher quality cocoa.
- **Research institutions** in the participating countries - enhanced NIR capacity and “Cocoa Quality Maps” from different growing regions
- **Cocoa Marketing Boards, Co-operatives and Cocoa Shippers** - information generated can be developed into a quality control tool that can ensure the delivery of good quality fine or flavour cocoa beans
- **Countries producing fine or flavour cocoa** - prospect of expanding their market share of high quality cocoa and exploring niche and direct marketing opportunities with the benefit of premium prices and higher farmer income
- **Manufacturers** - results will be enable them to objectively establish if a lot of cocoa beans delivers a flavour profile and quality attributes specific to that geographic origin.
- **Consumers** – fine cocoa products of more consistent quality

Application of Project Outcomes

- Development and application of high throughput measures of quality variables and an unambiguous cocoa quality control tool
- Using the Cocoa Quality Maps and Cocoa Quality network to formulate niche marketing strategies using Geographic Information

Alignment with other initiatives and commercial certification programmes

- Opportunity for Synergy & Harmonization of efforts with this project and:
  - European Committee for Standardization (CEN)
  - Expert working group on Food Safety and Quality

Project Budget

Summary of Project Costs by Component and Year in US $

	Project Components	Cost Y1	Cost Y2	Cost Y3	Total
1	Introduce and develop local capacity to conduct and apply NIRS analysis for quality and origin differentiation and carry out organoleptic evaluations	154,562	0	0	154,562
2	Create local and project wide NIRS and flavour profile databases of export grade cocoa	985,000	163,198	143,000	1,291,198
3	Develop prediction models and "Cocoa quality maps" of the main producing regions/zones and assess indices for certification and quality control based on NIRS, flavour profiles and other cocoa quality markers.	2,000	2,000	20,000	24,000
4	Disseminate findings and use the information generated to formulate strategies to improve the marketing competitiveness for niche marketing.	6,000	0	69,278	75,278
5	Project Implementation and Management	129,900	129,900	129,900	389,700
	Total	1,277,462	295,098	362,178	1,934,738
	5% Contigency	63,873	14,755	18,109	96,737
	Grand Total	**1,341,335**	**309,853**	**380,287**	**2,031,475**

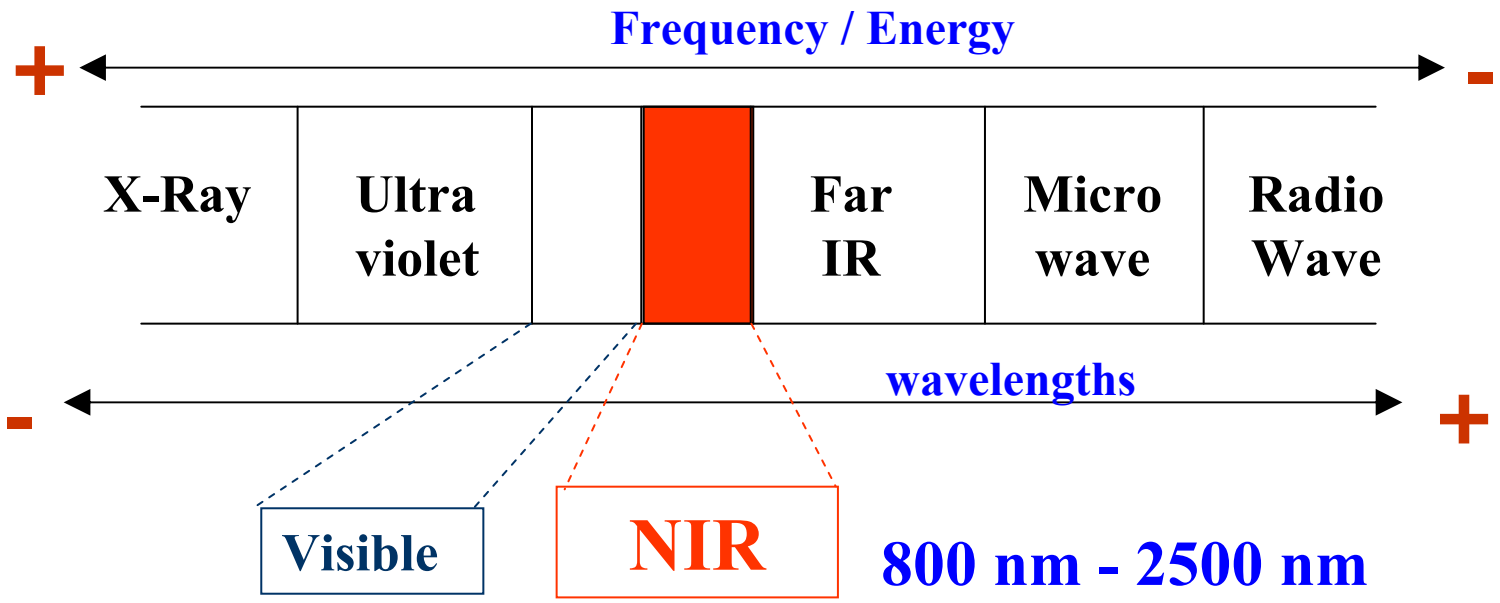
Thank You!

Questions?

Discussion Slides

Source: Fabrice Davrieux, CIRAD

Near infrared refers to the spectral range of electromagnetic radiations whose wavelengths are between the visible and mid-infrared, i.e. between 800 and 2 500 nm.

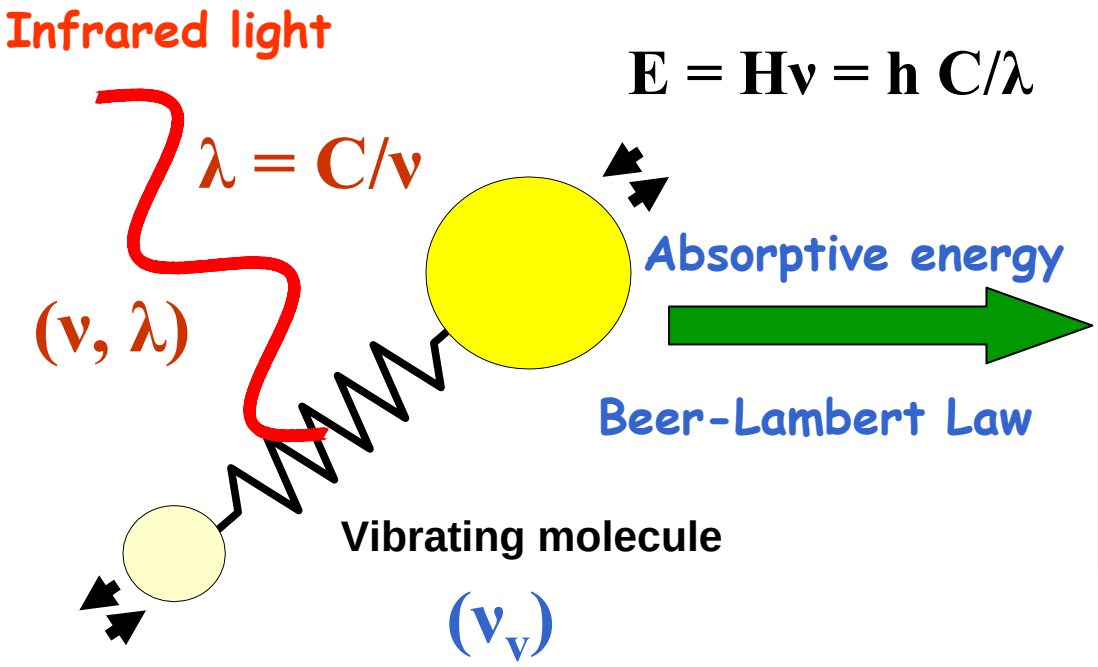


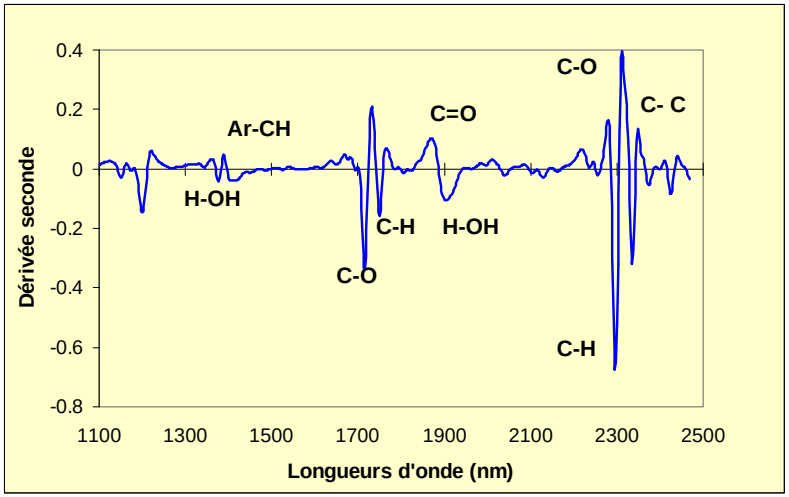
The absorption in this region arise as echoes of the fundamental absorptions in the mid IR

NIRS is primarily concerned with organic molecules, made up of atoms of Carbon, Oxygen, Hydrogen, Nitrogen, etc., linked to each other by covalent chemical bonds.

NIRS is the measurement of near infrared light absorption (wavelength and intensity) by a sample.

The technique is based on the vibrational properties of molecules and their interactions with light.

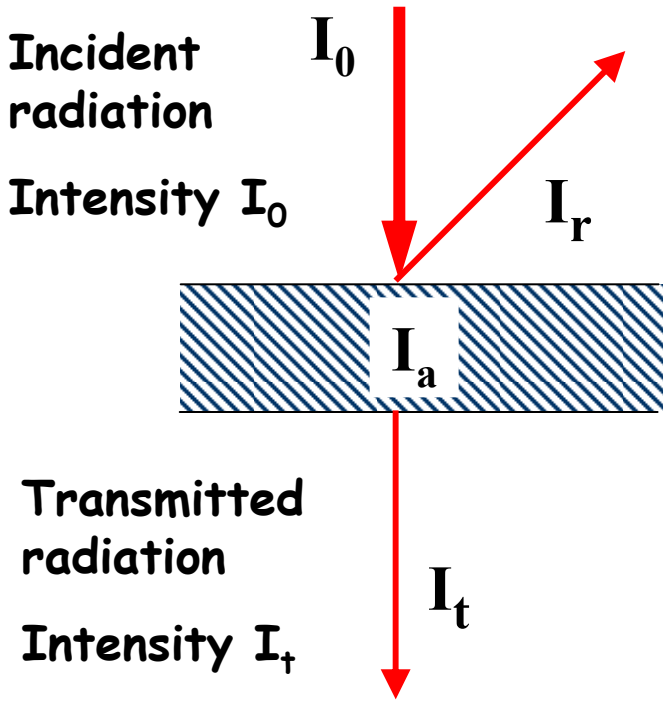




Spectrum : fingerprint

There is absorption of light energy when the frequency of the radiation hitting the bond is equal to the vibration frequency of that bond. A wavelength can therefore be linked to a given bond, e.g. 1 900 nm and H-OH bond of the water molecule.The quantity of light energy (photons) absorbed follows Beer-Lambert's law.

Beer – Lambert 's Law : $A_\lambda = \varepsilon Cl$

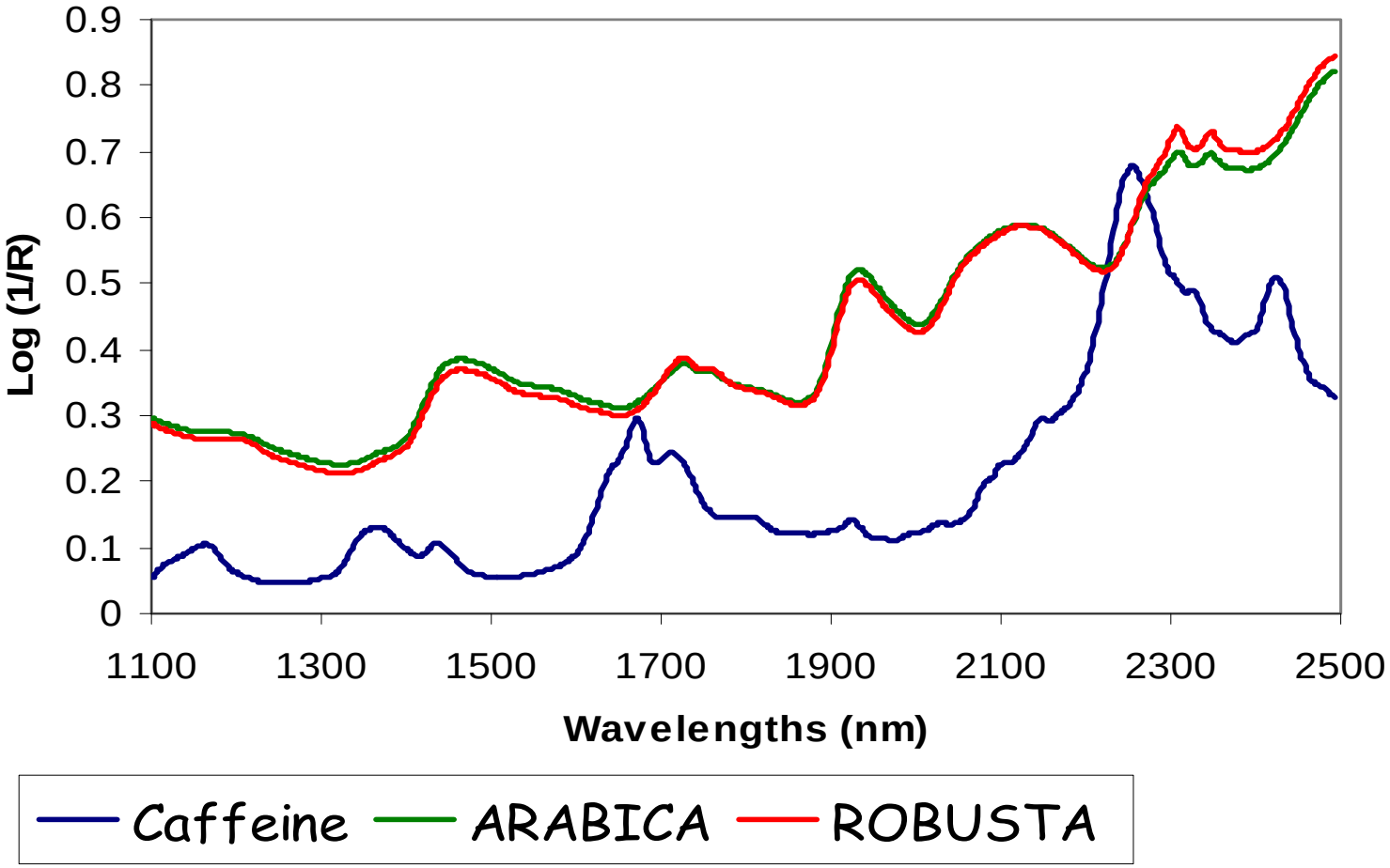


REFLECTANCE $R = \frac{I_r}{I_0}$

TRANSMITTANCE $T = \frac{I_t}{I_0}$

ABSORBANCE $A = \text{Log}\left(\frac{1}{R}\right) = \text{Log}\left(\frac{1}{T}\right)$

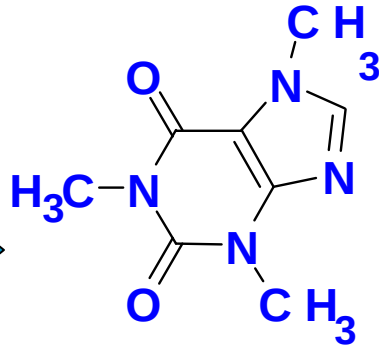
Measurement of I_t or I_r gives rise to an absorbance measurement proportional to the number of analyte molecules encountered, and so proportional to the concentration of the constituent



The absorption spectrum is the resultant of all the elementary absorption processes. This gives a veritable fingerprint of the product that is uniquely dependent upon its history.

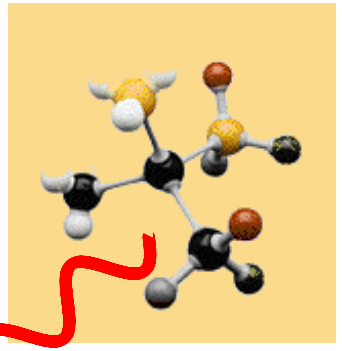
NIRS spectra actually contain relevant information about the nature, the physical characteristics and the chemical composition of the studied samples. By linking this spectral data to qualitative and quantitative data, it becomes possible to identify and authenticate the product.

Product to analyze



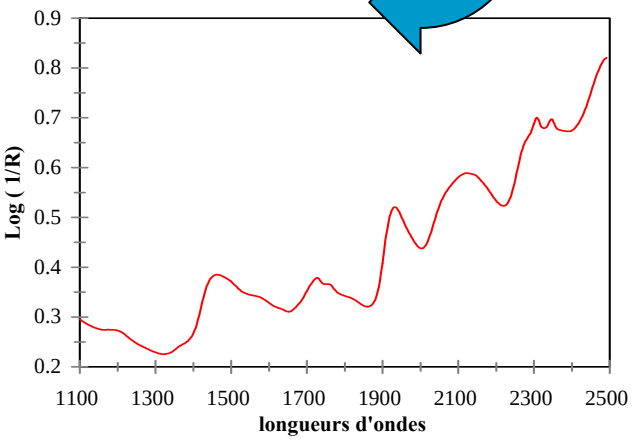
Chemical constituent
Eg : Caffeine

Chemical bonds

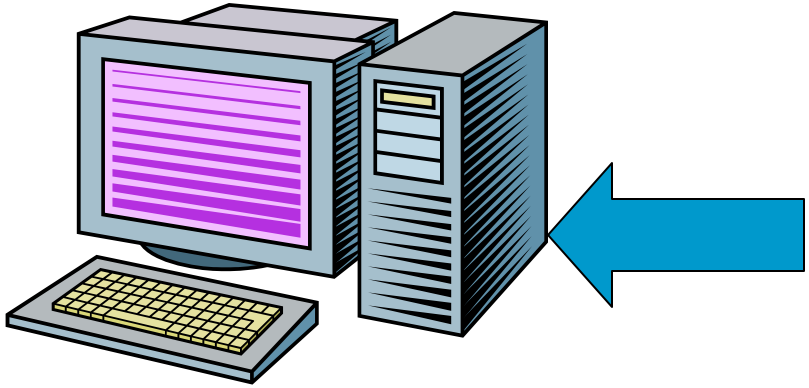


Infrared light

Absorbed Energy



Spectrum fingerprint

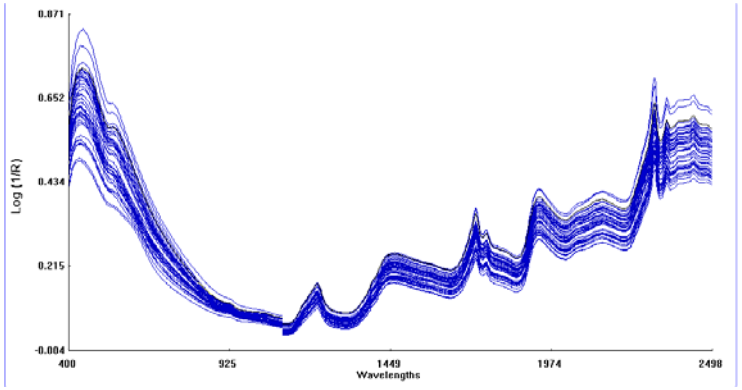


Comparison to the spectral data bases : interpretation / prediction

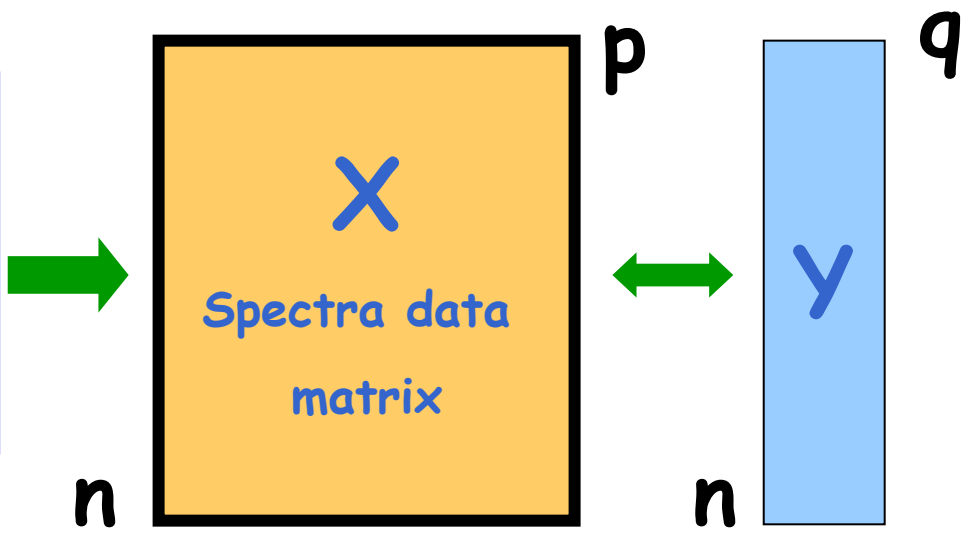
Qualitative Analyse

Quantitative Analyse

NIRS : calibration principe



Spectra database (n)



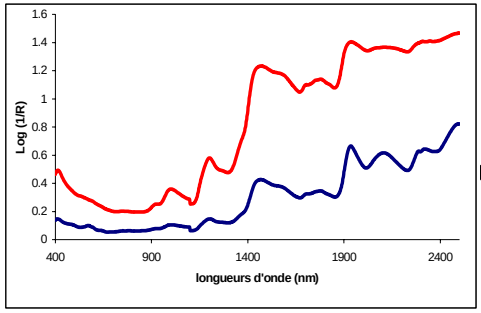
Physical and/or chemical data

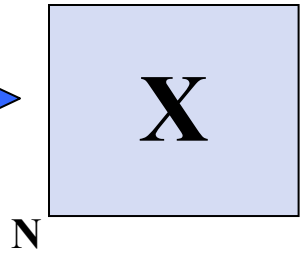
$$\hat{Y} = b_0 + b_1X_1 + ...b_iX_i + b_pX_p$$

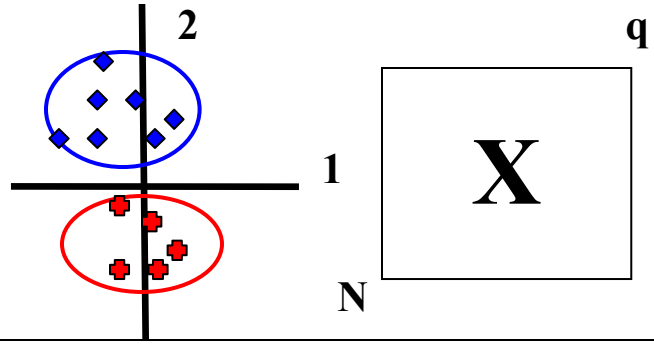
Quantification of a constituent by NIRS requires a prior calibration stage, which establishes a linear model linking spectral data to quantifications obtained by a reference method

The prediction equation linking absorption values and reference values is of the multilinear type. It expresses constituent contents as a function of absorbance at certain wavelengths.

Four steps to develop a calibration

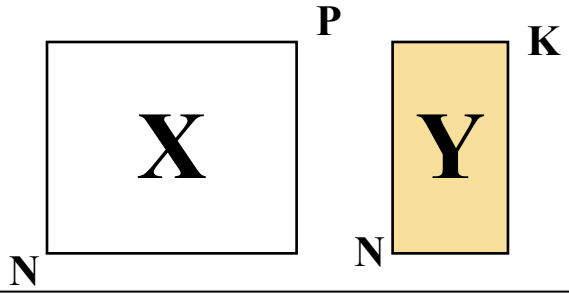


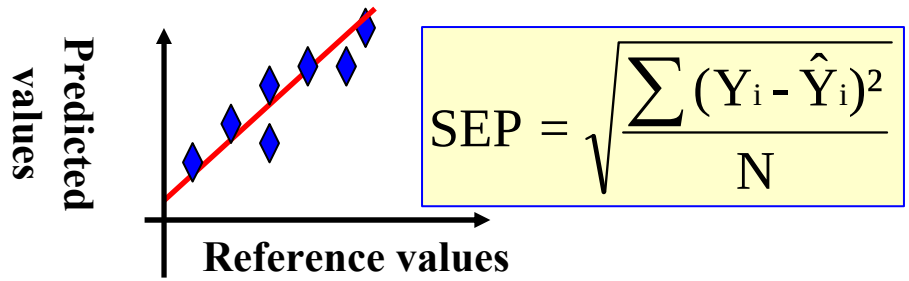




I : Acquisition of the spectra
Matrix of the spectral data

II : Construction of the spectral population
Principal components analysis. Calculation of the Mahalanobis (H) distances, definition of limits of population. 2d and 3d plots.





III : Calibration models
Regressions between the spectral data and the reference values. Detection of the outlier in Y (***t*** test).

IV : Validation
Estimation of the standard error of prediction from an independent set of samples

Factors and sources of spectral variations

- Chemical composition,
- Species or variety,
- Geographical origin,
- Technological treatments (post-harvest processing),
- Type of storage,
- Sampling,
- Sample homogeneity,
- Storage and analysis temperature,
- Grinding (may affect the water content)
- Size and shape of particles
- Compaction intensity, which affects the optical path

The role of CIRAD – Technical Backstopping

- Advise on suitable NIRS equipment
- Requirements for setting up NIRS laboratories
- Provide training on sample preparation for NIRS evaluations and data analysis principles and techniques.
- Provide independent sub sample cross referencing (ring testing) of NIR equipment calibration
- Provide a standardised analytical base in the measurement of cocoa butterfat contents, purines (theobromine and caffeine via HPLC) and other aroma volatiles (via SPME-GCMS) on a subset of samples from each project member country

Application of Project Outcomes

- The information generated can be developed into a quality control tool that can ensure the delivery of good quality fine or flavour cocoa beans
- The information that can be used as criteria to formulate marketing strategies that will allow farmers to achieve or retain the premiums typically commanded for this niche market
- The introduction of a quality control tool will provide the opportunity for farmers to promote quality attributes specific to a geographic region, allowing them to reclaim at least part of the extra value associated with the chocolate brand marketing, based on the fine or flavour cocoa they produce
- Manufacturers will be able to objectively establish if a lot of cocoa beans deliver a flavour profile and quality attributes specific to that geographic origin
- Countries producing fine or flavour cocoa will have the prospect of expanding their market share of cocoa with the benefit of premium prices

Project Budget by Country

	Component	Dom. Rep	Ecuador	Nicaragua	Trinidad & Tobago	Venezuela	PEA	ICCO	Grand Total
1	Introduce and develop local capacity to conduct and apply NIRS analysis for quality and origin differentiation and carry out organoleptic evaluations	13,654	13,530	14,082	14,654	14,762	83,880	0	154,562
2	Create local and project wide NIRS and flavour profile databases of export grade cocoa	246,656	309,470	239,398	225,256	270,418	0	0	1,291,198
3	Develop prediction models and "Cocoa quality maps" of the main producing regions/zones and assess indices for certification and quality control based on NIRS, flavour profiles and other cocoa quality markers.	4,800	4,800	4,800	4,800	4,800	0	0	24,000
4	Disseminate findings and use the information generated to formulate strategies to improve the marketing competitiveness for niche marketing.	0	0	0	0	0	75,278	0	75,278
5	Project Implementation and Management	52,200	52,200	52,200	52,200	52,200	83,700	45,000	389,700
	Total	317,310	380,000	310,480	296,910	342,180	242,858	45,000	1,934,738
	Contigency (5%)	15,866	19,000	15,524	14,846	17,109	12,143	2,250	96,737
	Grand Total	**333,176**	**399,000**	**326,004**	**311,756**	**359,289**	**255,001**	**47,250**	**2,031,475**

Acknowledgements

Financial support from Mars Global Chocolate to attend these meetings is gratefully acknowledged