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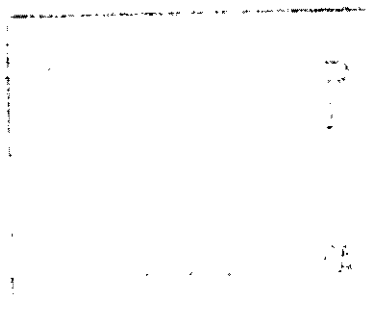
Laboratory Enhancements to Improve Human Nutrition

CIAT Final Report to Monsanto Fund 2010

In December 2007, the Monsanto Fund approved a US\$281,000 grant to the *Centro Internacional de Agricultura Tropical (CIAT)* based in Colombia to carry out laboratory enhancements to improve human nutrition. These funds were used in the course of 2008 to purchase equipment for the newly formed Nutrition Quality Laboratory at CIAT. This document summarizes the activities the Laboratory completed between January 2008 and January 2010 and corresponds to the final report requested by the Monsanto Fund.

In the past two years, Laboratory personnel have been dedicated to the following major tasks:

1. Set up Laboratory
2. Receive training
3. Complete protocols and procedures
4. Implement quality-control activities
5. Provide training
6. Analyze samples
7. Communicate findings
8. Obtain complementary funding



Accomplishments for each of these tasks are noted below.

Laboratory personnel

The laboratory is directed by Helena Pachón, who holds a PhD in nutrition. Day-to-day coordination is the responsibility of Darwin Ortiz, a chemist; the implementation of a quality-control system is led by Dayron Gutierrez, a food chemistry technologist; and analyses are carried out by Ingrid Aragón, a chemist, and María Luisa Cortés, an agricultural engineer and plant-production specialist, who shares 50% of her time with the CIAT Bean Breeding Program. All staff are funded by the Canadian-supported AgroSalud project (www.AgroSalud.org).

The Laboratory contributed to 9 students completing theses or internships in the 2008-2010 period (Annex 1). Students ranged widely in characteristics such as previous laboratory experience, university where studying, graduate or undergraduate level, and country of origin. Laboratory personnel aimed to instill fundamental skills and principles in students such as the importance of quality control, working in a team setting, written communication (proposals and articles), minimizing analytical errors, safety as paramount, statistically analyzing data, interpreting results, and presenting findings in a public forum.

Set up Laboratory

In April 2008, the Laboratory was situated in the northeast corner of the CIAT campus in Palmira, Valle del Cauca (Annex 2). From that time forward and overseen by the Laboratory's Coordinator, Darwin Ortiz, the Laboratory was organized with respect to

infrastructure (e.g., electricity capacity enhanced, air conditioning unit installed), safety (e.g., signs posted), and aesthetics (e.g., walls painted). Equipment options were studied, quotes reviewed, and models ordered. Upon receipt, acquisitions were organized in the Laboratory according to a logical way to process samples (e.g., sample receipt, sample preparation, weighing station, HPLC section as described in Annex 3) and following manufacturers' recommendations (e.g., NIRS equipment placed where temperature and humidity can be well-controlled). In December 2009, an adjoining office was annexed to the Laboratory to provide desk space for staff and students.

Receive training

Laboratory personnel and students participated in 11 training events in 2008-2010 (Annex 4). These trainings included fundamentals of how to operate equipment, implementing specific protocols, ISO 17025 quality-control system, and statistical analysis of data.

Complete protocols and procedures

The Laboratory has a suite of analyses it can provide: tryptophan quantification, carotenoid quantification by UV-VIS, carotenoid identification and quantification by HPLC, soluble protein quantification, phytate quantification, quantification of iron and zinc via near-infrared reflectance spectroscopy (NIRS), *in vitro* iron dialyzability, *in vitro* carotenoid bioaccessibility, *in vitro* protein digestibility, and anti-oxidant activity. Each of these is accompanied by a protocol to ensure the analysis is carried out reliably and accurately. The protocol, in turn, is supported by a rigorous validation process that identifies the linearity, accuracy, precision, robustness, limit of detection, and limit of quantification of the analysis. Validation reports were completed or are in process for all of the analyses the Laboratory provides.

Beyond implementation of the protocols, a set of procedures needs to be standardized to reduce the variability and inaccuracy of results. These procedures include the following:

- Identification of homogeneous samples that are used in all analyses. These samples have been analyzed repeatedly and the range of values is known. Thus, if subsequent analyses find results outside the known range, implementation of the protocol is scrutinized to identify and correct errors.
- Establishment of standardized cooking procedures. Since much of the Laboratory's work centers on beans, cassava, maize, rice and sweet potato, standardized cooking procedures have been established for these crops. All future analyses will use the standardized cooking procedures in addition to other cooking methods required for the specific study. By ensuring that all samples are cooked in the same manner, the Laboratory will be able to compare results from different experiments carried out in different years.

Finally, it is important to know the true cost of running the Laboratory and in particular each of the analyses which prospective clients may be interested in. As such, on an annual basis, the Cost Analysis of Research and Breeding Operations (CARBO) methodology has been completed and prices set accordingly for Laboratory services.

Implement quality-control activities

As part of the Laboratory's efforts to obtain certification by ISO, a quality-control system is being implemented under the leadership of Dayron Gutiérrez. The main tasks completed in the past 2 years are as follows:

- Trained in ISO auditing and certification (Annex 4).
- Created awareness among Laboratory staff and students of the importance of adhering to a quality-control system.
- Carried out and wrote up validation studies for the following analytical methods: tryptophan determination, soluble-protein determination, *in vitro* iron dialyzability, and *in vitro* protein digestibility.
- Developed, edited and implemented operations manuals (Annex 5).
- Led and participated in inter-laboratory trials to gauge the Laboratory's accuracy and precision compared with other Laboratories for several methods (Annex 6).
- Internal audit completed by an ISO 17025 auditor to evaluate advances made in certifying the Laboratory. After addressing issues raised in the audit, the next step is to have an external audit completed which, if successful, would certify one of the Laboratory's methods.
- Repeatability and reproducibility (R&R) trials held and are being conducted among Laboratory staff to determine how well they run each analysis. Results to date suggest good R&R for tryptophan quantification and *in vitro* iron dialyzability, indicating that any Laboratory staff member can run these analyses and obtain precise and accurate results.

Provide training

In the past 2 years, Laboratory staff have provided training to 9 students (Annex 1), as well as 8 individuals from CIAT and other organizations (Annex 7). The latter is a good indication that the Laboratory's quality services are valued by others.

Analyze samples

The "bread and butter" of the Laboratory is to analyze food samples, yielding accurate and precise results for the research projects we participate in or for the clients who pay for this service. A total of 6038 samples were received from January 2008 to January 2010; 4703 (78%) of these have been analyzed (Annex 8). To date, no complaints have been fielded from clients, internal or external to CIAT. During this 2-year period, 20 research projects were completed or initiated (Annex 9), with the active participation of Laboratory staff and students.

Communicate findings

As scientists we are obligated to communicate findings widely so that they can be applied towards solving pressing social and scientific problems. In the Laboratory, we have done this through 4 major mechanisms from January 2008 to January 2010:

- 20 presentations in scientific and non-scientific venues (Annex 10).

- 8 manuscripts in preparation, submitted or published in peer-reviewed journals (Annex 9).
- ~436 visitors to the Laboratory hosted (Annex 11).
- 8 communication pieces developed to provide to interested parties (Annex 12).

Obtain complementary funding

To staff the Laboratory, provide stipends to students, cover minor equipment and supplies, develop communications pieces, pay for trainings, and to participate in events, complementary funding has been obtained from several sources:

- AgroSalud project
- HarvestPlus project
- CIAT's Agrobiodiversity Program
- CIAT's Tropical Fruits Program
- CIAT's Cassava Program
- CIAT's Bean Programs
- CIAT's Rice Program
- Corporación Biotec
- Japan-CGIAR Fellowship
- Colciencias
- CIAT's Fund to Build Human Resources
- Centro Nacional de Innovaciones Biotecnológicas (CENIBiot) in Costa Rica
- Colombia's ITALCOL
- Bioversity International
- Grupo de investigación de Biología Integrativa (BINTE), Facultad de Salud, Universidad del Valle in Colombia

Final remarks

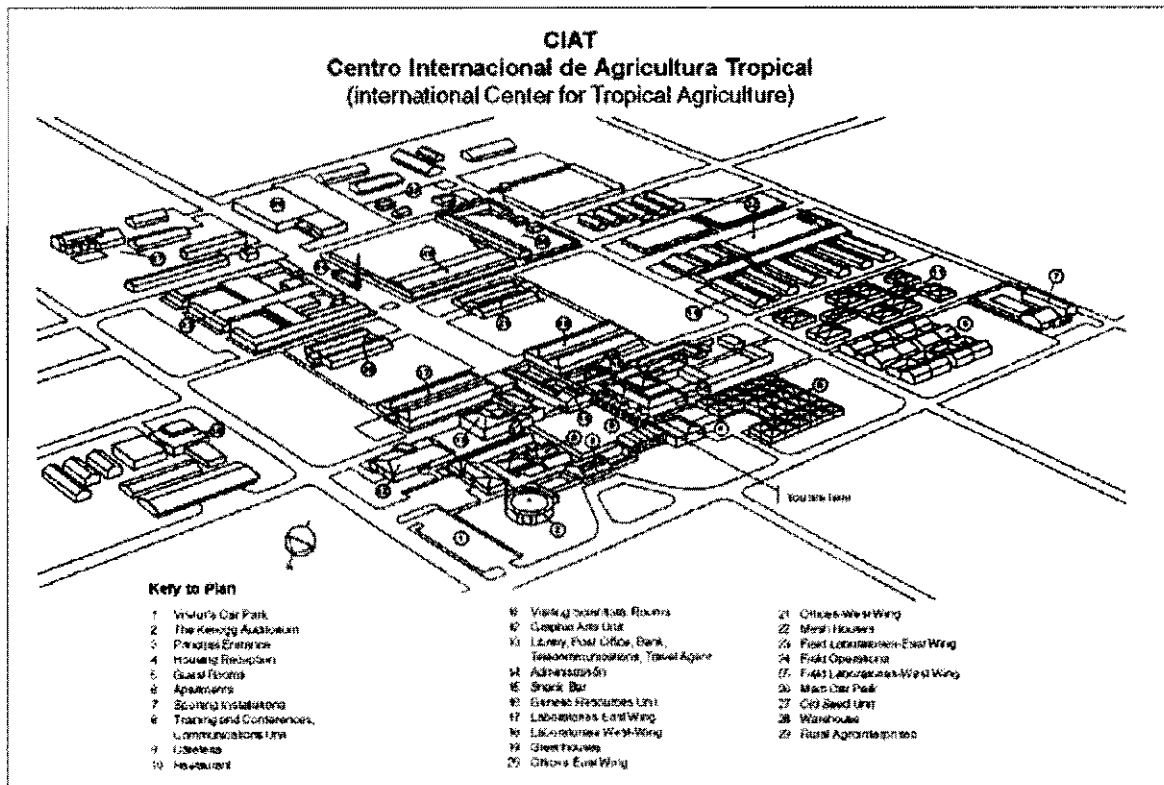
In summary, CIAT gratefully acknowledges the support provided by the Monsanto Fund to establish the Nutrition Quality Laboratory. The Laboratory has aided CIAT in its mission to reduce hunger and poverty, and improve human health in the tropics, through research aimed at increasing the eco-efficiency of agriculture. Towards this end, the Laboratory strives to conduct food-based nutrition research that is socially and scientifically relevant. Additionally, the Laboratory has provided a mechanism for training students and scientists from Colombia and abroad—an activity that CIAT has prioritized in its 40-year history. As this first 2-year phase of the Laboratory comes to an end, we look forward to contributing solutions to address food and nutrition insecurity in Colombia, Latin America, and the world.

Annex 1. Students who contributed to the Laboratory's activities in 2008-2010.

Name	University	Academic Program	Role	Dates in Laboratory	Project in Laboratory	Presentations Given
Mónica Gutiérrez	Universidad del Valle	Food Technology	Intern	15 August 2007-14 February 2008	Implementation of several methods: <i>in vitro</i> protein digestibility, tryptophan quantification, and <i>in vitro</i> iron dialyzability	None
Mónica Pizarro	Universidad Nacional de Colombia-Palmira	Agroindustrial Engineer	Intern	4 January 2008-15 February 2008	Validation of a soluble-protein determination method	Validating the Lowry Method of determining soluble protein content, CIAT, 13 February 2008
Sayda Pico	Universidad Industrial de Santander	Nutrition and Dietetics	Intern	12 May 2008-11 November 2008	Evaluation of the nutritional quality of leaf extracts prepared from the foliage of different biofortified crops	Evaluation of the nutritional quality of leaf extracts prepared from the foliage of different crops, CIAT, 5 November 2008. XIII Congreso Colombiano de Dietistas y Nutricionistas. Colombia. 13 Nov 2009.
María Alejandra Lozano	Universidad del Valle	Chemistry	Bean Program Thesis Student	4 June 2008-14 November 2008	The quantification of phytates via HPLC of a population of common beans (<i>Phaseolus vulgaris</i>) and identification of QTLs associated with them	None
Hiroko Kunori	Tokyo University of Agriculture	Tropical Horticulture	Japan CGIAR Fellow	18 November 2008-15 January 2009	Implementation of an analytic method to evaluate the anti-oxidant capacity of biofortified crops	None

Name	University	Academic Program	Role	Dates in Laboratory	Project in Laboratory	Presentations Given
Ingrid Aragón	Universidad del Valle	Chemistry	Intern, Thesis student	10 March 2008-31 May 2009	Validation of an <i>in vitro</i> method to assess the iron bioavailability of biofortified crops	Validation of an <i>in vitro</i> method to assess the iron bioavailability of biofortified crops, CIAT, 4 March 2009. Congreso Iberoamericano de Ingeniería de Alimentos. Colombia. 8 September 2009.
Paola Imbachi	Universidad del Cauca	Agroindustrial Engineer	Intern, Thesis student	12 May 2008-31 May 2009	Protein-quality evaluation of different Colombian recipes prepared with biofortified maize	Protein-quality evaluation of different Colombian recipes prepared with biofortified maize, CIAT, 13 May 2009. Congreso Iberoamericano de Ingeniería de Alimentos. Colombia. 9 September 2009.
Hiroko Kunori	Tokyo University of Agriculture	Tropical Horticulture	Japan CGIAR Fellow	18 November 2008-15 January 2009	Implementation of an analytic method to evaluate the anti-oxidant capacity of biofortified crops	None
Lizbeth Lorena López Parra	Universidad del Valle	Chemistry	Corporación Biotec intern, Master's thesis student	30 June 2009-30 September 2010	Evaluation of anti-oxidant activity and its relationship to polyphenols in <i>musa paradisiaca</i>	None

Annex 2. Nutrition Quality Laboratory located in the northeast corner of CIAT, in the east wing of the field laboratories (building 23 in the map).



Annex 4. Trainings completed by Laboratory personnel and students from 2008-2010.

Training Received	Training Institution	Training Date	Persons Trained
Application of the tryptophan quantification method (80 hours)	Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT)	1-4 April 2008	<ul style="list-style-type: none"> • Ingrid Aragón • Dayron Gutiérrez • Mónica Gutiérrez • Darwin Ortiz
Basics and use of liquid chromatography and software for HPLC (60 hours)	Khymos	27-30 May and 1-4 July 2008	<ul style="list-style-type: none"> • Ingrid Aragón • Dayron Gutiérrez • María Alejandra Lozano • Darwin Ortiz
Statistical applications in experimental design (24 hours)	CIAT	20-28 May and 3-5 June 2008	<ul style="list-style-type: none"> • Ingrid Aragón • Dayron Gutiérrez
Theory behind and use of lyophilizer (1 hour)	G&C Sucesores	18 July 2008	<ul style="list-style-type: none"> • Ingrid Aragón • Dayron Gutiérrez • Paola Imbachi • María Alejandra Lozano • Darwin Ortiz • Sayda Pico
Implementation of a laboratory quality-control system based on ISO 17025 (12 hours)	ICONTEC	11-12 August 2008	<ul style="list-style-type: none"> • Dayron Gutiérrez • Darwin Ortiz • Helena Pachón
<i>In vitro</i> method to determine the bioaccessibility of carotenoids (80 hours)	Ohio State University	11-24 October 2008	<ul style="list-style-type: none"> • Darwin Ortiz
NIRS: principles, concepts and application (75 hours)	Centre de coopération internationale en recherche agronomique pour le développement (CIRAD)	2-5 December 2008	<ul style="list-style-type: none"> • Ingrid Aragón • María Luisa Cortés • Darwin Ortiz
NIRS: Quality control and traceability of products and processes (264 hours)	Universidad de Córdoba (Spain)	23 June-6 August 2009	<ul style="list-style-type: none"> • María Luisa Cortés
Statistical methods and application using SPSS software (40 hours)	Consultant, Universidad Javeriana, Universidad Autónoma del Occidente	1 August-2 September 2009	<ul style="list-style-type: none"> • Ingrid Aragón • Dayron Gutiérrez • Darwin Ortiz
Preparation of project proposals (45 hours)	CIAT	28 September-9 October 2009	<ul style="list-style-type: none"> • María Luisa Cortés • Darwin Ortiz
Training of internal auditors in a laboratory quality-control system based on ISO 17025 (52 hours)	ICONTEC	6-10 July 2009	<ul style="list-style-type: none"> • Dayron Gutiérrez

Annex 5. Documents developed (in Spanish) as part of the Laboratory's quality-control system.

Type	Spanish title	English title
Manuals	Manual general	General manual
	Manual de calidad	Quality manual
Operational procedures	Manejo de los documentos del sistema de calidad	Use of documents in the quality-control system
	Entrenamiento, capacitación, evaluación	Training and evaluation
	Manejo de reclamos y sugerencias	Managing complaints and suggestions
	Selección de proveedores	Selection of vendors
	Acciones correctivas	Corrective actions
	Acciones preventivas	Preventive actions
	Programa de las 5s	The 5S Program
	Seguimiento de la satisfacción de usuario	User satisfaction follow up
	Control de trabajo no conforme	Managing unsatisfactory work
	Auditoría interna de calidad	Internal quality audit
Technical procedures	Revisión del sistema de gestión de calidad	Review of the quality-control system
	Revisión de solicitudes	Review of requests
	Manejo de muestras para análisis en el laboratorio de calidad	Sample handing for analyses in the laboratory
	Solicitud, uso y desecho de reactivos e insumos para el laboratorio	Request, use and discarding of reagents and other laboratory supplies
	Manejo de registros	Registry management
	Mantenimiento y calibración de equipos y patrones de referencia	Maintenance and calibration of equipment and reference standards
	Ingreso del personal ajeno al laboratorio	Visitors to the laboratory
	Estimación de la incertidumbre	Estimating uncertainty
	Validación de métodos	Validation of methods
	Aseguramiento de la calidad	Quality assurance
	Control de indicadores de gestión	Managing quality indicators
	Evaluación de los resultados de análisis interlaboratorio	Evaluating the results of interlaboratory trials
	Manejo de informes de resultados	Managing results reports
	Manejo de patrones de verificación	Managing verification standards
	Manejo de patrones internos para los análisis	Managing internal standards for analyses
Protocolos de validación de los métodos de análisis de triptófano, proteína soluble, digestibilidad <i>in vitro</i> de proteína, dializabilidad <i>in vitro</i> de hierro	Validation protocols for the following methods: tryptophan, soluble protein, <i>in vitro</i> protein digestibility, <i>in vitro</i> iron dialyzability	

Type	Spanish title	English title
Procedures for the equipment	Operación de las balanzas	Operating balances
	Operación de pHmetro	Operating the pH meter
	Operación de la centrífuga	Operating the centrifuge
	Operación del purificador de agua	Operating the water purifier
	Operación del equipo baño María	Operating the water bath
	Operación de las planchas calentadoras	Operating the heating plates
	Operación del equipo limpiador ultrasónico	Operating the ultrasonic cleaning equipment
	Operación del ultrafreezer	Operating the ultrafreezer
	Operación del equipo homogenizador	Operating the homogenizer
	Operación del rotaevaporador	Operating the rotary evaporator
Operación del horno	Operating the oven	
	Manejo de las pipetas eppendorf	Managing the Eppendorf pipettes
Technical instruction guide	Manejo de cuadernos	Managing notebooks
	Manejo de desechos químicos	Managing chemical waste
	Manejo de registros en papel	Managing written registries
	Manejo de cartas control	Managing control cards
	Administración de contramuestras	Managing samples after analyses have been completed
	Codificación de reactivos	Coding reagents
Operational instruction guide	Descarte de envases de reactivos	Discarding reagent packaging
	Descarte de desechos químicos	Discarding chemical waste
	Contenido de los documentos del sistema	Content of the documents in the system
Operational instruction guide	Escritura de un procedimiento	Writing a procedure
	Escritura de un instructivo	Writing an instruction guide
	Escritura de un formato	Writing a form
Technical references	Manejo de material de lavado	Managing cleaning materials
	Glosario de términos del sistema de calidad	Glossary of terms in the quality-control system
	Sistema internacional de unidades	International Units system
	Evaluación técnica de los analistas	Technical evaluation of analysts
	Listado de reactivos y estándares	List of reagents and standards
	Recomendaciones para la toma de muestra	Recommendations for obtaining a sample
Operational references	Condiciones ambientales del laboratorio	Environmental conditions in the laboratory
	Área física	Physical area
Operational references	Confidencialidad de los resultados	Confidentiality of results
	Perfiles laborales	Position profiles
	Tarifas externas	External prices
	Tarifas internas	Internal prices
	Estandarización de métodos de cocción para diferentes alimentos	Standardization of cooking methods for different foods

Annex 6. Information about the inter-laboratory trials the Laboratory led or participated in in 2009.

Inter-laboratory trial led

Led by: Dayron Gutiérrez, CIAT's Nutrition Quality Laboratory, Colombia.

Methods assessed: tryptophan quantification, soluble protein quantification, iron quantification, nitrogen quantification, *in vitro* protein digestibility, and *in vitro* Iron dialyzability.

Laboratories that participated:

- Departamento de nutrición y calidad, Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP), Ecuador.
- Laboratorio de análisis de alimentos, Universidad Simón Bolívar, Venezuela.
- Laboratorio de calidad de semillas, Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT), México.
- Laboratorio del departamento de ciencia de los alimentos, Universidad de Cornell, Estados Unidos.
- Laboratorio de química agrícola, Centro Nacional de Tecnología Agropecuaria y Forestal (CENTA), El Salvador.
- Laboratorio de servicios analíticos, Centro Internacional de Agricultura Tropical (CIAT), Colombia.
- Laboratorio de servicios de análisis, Empresa Brasileira de Pesquisa Agropecuária (Embrapa), Brasil.
- Unidad de nutrición humana, Universidad Agrícola de Atenas, Grecia.

Inter-laboratory trial participated in

Led by: Mieko Kimura, Universidade Estadual Paulista (UNESP), Brazil.

Method assessed: carotenoid quantification.

Annex 7. List of individuals who have received training by CIAT's Nutrition Quality Laboratory staff.

Individual and Institution	Training Topic	Dates
Paulo Izquierdo, CIAT's Andean Bean Program	Use of NIRS	March, 2009
Katherine Loaiza, CIAT's Rice Breeding Program	Use of NIRS	March, 2009
Andrés Escobar, CIAT's Cassava Breeding Program	Use of HPLC	March, 2009
Sandra Patricia Loaiza, CIAT's Forages Program	Use of UV-Vis	November, 2009
Helbert Asencio, Facultad de Salud, Universidad del Valle	Use of HPLC	August, 2009
Santiago Castaño, Facultad de Salud, Universidad del Valle	Use of HPLC	August, 2009
Javier Barboza Zumbado, CENIBiot, Costa Rica	Analyzing nutrition quality in foods	January, 2010
Juan Sebastián Ramírez Navas, Escuela de Ingeniería de Alimentos, Universidad del Valle	<i>In vitro</i> iron dialyzability method	January, 2010

Annex 8. Samples received and analyzed in the Laboratory from January 2008 to January 2010.

Institution	Number of Samples	Sample Type	Analyses Requested	Analyses Completed
AgroSalud, Universidad del Cauca	422	Maize	<ul style="list-style-type: none"> ▪ Tryptophan quantification ▪ <i>In vitro</i> protein digestibility ▪ Soluble-protein quantification 	<ul style="list-style-type: none"> ▪ Tryptophan quantification ▪ Soluble-protein quantification
AgroSalud, Nicaragua	2	Rice	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability 	<ul style="list-style-type: none"> ▪ None
AgroSalud, Universidad Industrial de Santander	19	Leaf extract	<ul style="list-style-type: none"> ▪ Tryptophan quantification ▪ Soluble-protein quantification ▪ <i>In vitro</i> protein digestibility ▪ <i>In vitro</i> iron dialyzability 	<ul style="list-style-type: none"> ▪ Tryptophan quantification ▪ Soluble-protein quantification ▪ <i>In vitro</i> protein digestibility ▪ <i>In vitro</i> iron dialyzability
AgroSalud, Colombia	6	Maize	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability 	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability
AgroSalud, Clayuca	36	Maize	<ul style="list-style-type: none"> ▪ Tryptophan quantification ▪ <i>In vitro</i> protein digestibility ▪ Soluble-protein quantification 	<ul style="list-style-type: none"> ▪ Tryptophan quantification ▪ <i>In vitro</i> protein digestibility ▪ Soluble-protein quantification
AgroSalud, Empresa PROPOMIEL	57	Meat, dairy products	<ul style="list-style-type: none"> ▪ <i>In vitro</i> protein digestibility ▪ Soluble protein quantification 	<ul style="list-style-type: none"> ▪ <i>In vitro</i> protein digestibility ▪ Soluble protein quantification
AgroSalud, Cauca Project	75	Beans Maize	<ul style="list-style-type: none"> ▪ Tryptophan quantification 	<ul style="list-style-type: none"> ▪ Tryptophan quantification
AgroSalud, Effect of cooking on iron bioavailability	36	Maize, Bean	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability 	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability
CIAT AgroSalud	70	Maize	<ul style="list-style-type: none"> ▪ Tryptophan quantification 	<ul style="list-style-type: none"> ▪ Tryptophan quantification
CIAT AgroSalud	5	Rice	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability 	<ul style="list-style-type: none"> ▪ None
CIAT AgroSalud	6	Bean	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability ▪ Tryptophan quantification ▪ Soluble protein quantification ▪ <i>In vitro</i> protein digestibility ▪ Iron quantification 	<ul style="list-style-type: none"> ▪ None
CIAT AgroSalud	2	Food	<ul style="list-style-type: none"> ▪ Tryptophan quantification 	<ul style="list-style-type: none"> ▪ Tryptophan quantification
CIAT's Bean Program, Universidad del Valle	565	Bean	<ul style="list-style-type: none"> ▪ Phytate quantification 	<ul style="list-style-type: none"> ▪ Phytate quantification
CIAT's Rice Program	270	Rice	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability 	<ul style="list-style-type: none"> ▪ None

Institution	Number of Samples	Sample Type	Analyses Requested	Analyses Completed
EMBRAPA	18	Rice, Bean	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability ▪ Zinc bioavailability 	▪ None
Estación Territorial de Investigaciones Agropecuarias de Holguín (ETIAH)	3	Bean	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability 	▪ None
CIAT's Tropical Fruit Program	12	Chontaduro	<ul style="list-style-type: none"> ▪ Carotenoid quantification 	▪ Carotenoid quantification
Instituto de Investigaciones de Arroz, Cuba	1	Cereal-flour	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability ▪ Zinc bioavailability 	▪ None
CIAT Cassava Program	2319	Cassava	<ul style="list-style-type: none"> ▪ Carotenoid quantification ▪ Determination of antioxidant activity ▪ Protein by NIRS 	<ul style="list-style-type: none"> ▪ Carotenoid quantification ▪ Determination of antioxidant activity ▪ 1030 pending NIRS analysis
CIAT Biotechnology	62	Cassava	<ul style="list-style-type: none"> ▪ Carotenoid quantification 	▪ Carotenoid quantification
CIAT Bean Program	2000	Beans	<ul style="list-style-type: none"> ▪ Iron quantification 	▪ Iron quantification
Bioversity International, CIAT	5	Birititi Fruit from Amazonas	<ul style="list-style-type: none"> ▪ Carotenoid quantification 	▪ Carotenoid quantification
CIAT-CLAYUCA	40	Cassava	<ul style="list-style-type: none"> ▪ Carotenoid quantification 	▪ Carotenoid quantification
Universidad Simón Bolívar - Venezuela	3	Rice	<ul style="list-style-type: none"> ▪ <i>In vitro</i> iron dialyzability 	▪ <i>In vitro</i> iron dialyzability
CIMMYT	2	Maize	<ul style="list-style-type: none"> ▪ Tryptophan quantification 	▪ Tryptophan quantification
Corpoica	2	Maize	<ul style="list-style-type: none"> ▪ Tryptophan quantification 	▪ Tryptophan quantification
Total	6038			4703 (78%)

Annex 9. Research projects completed or initiated from January 2008 to January 2010.

Project	Responsible	Collaborators	Status
Validation of a soluble-protein quantification method	Dayron Gutiérrez	Paola Imbachi, Mónica Pizarro	Completed
Validation of an <i>in vitro</i> protein digestibility method	Dayron Gutiérrez	Paola Imbachi	Completed
Validation of a tryptophan-quantification method	Dayron Gutierrez	Paola Imbachi	Completed
<i>In vitro</i> bioavailability of iron, zinc and protein in biofortified beans and maize	Darwin Ortiz	Mónica Gutiérrez, Ingrid Aragón, CIAT Bean Program, FIDAR, Universidad del Valle	Completed; published in the Journal of Food Science
Validation of an <i>in vitro</i> iron dialyzability method	Ingrid Aragón	Dayron Gutiérrez, Darwin Ortiz, Universidad del Valle, AgroSalud	Completed
Comparison of an <i>in vitro</i> iron dialyzability method with <i>in vivo</i> iron bioavailability methods	Ingrid Aragón	Dayron Gutiérrez, Darwin Ortiz, Universidad del Valle, AgroSalud	Thesis completed; manuscript in preparation
Evaluation of the nutritional quality of leaf extracts prepared from the foliage of different biofortified crops	Sayda Pico	Dayron Gutiérrez, Ingrid Aragón, Andrés Escobar, Darwin Ortiz, Teresa Sánchez, Paola Imbachi	Completed; manuscript submitted to Archivos Latinoamericanos de Nutrición
Protein-quality evaluation of different Colombian recipes prepared with biofortified maize	Paola Imbachi	Dayron Gutiérrez, CIAT's Cassava Program, CLAYUCA	Thesis completed; manuscript submitted to Revista de Salud Pública México
The quantification of phytates via HPLC of a population of common beans (<i>Phaseolus vulgaris</i>) and identification of QTLs associated with them	María Alejandra Lozano	CIAT's Bean Program, Universidad del Valle, AgroSalud	Thesis completed
Protein digestibility of meat and milk products processed with or without sugar-cane honey as a preservative	Dayron Gutierrez	AgroSalud, Empresa PROPMIEL	Completed; manuscript in preparation
Evaluation of the anti-oxidant capacity of cassava	Hiroko Kunori	CIAT's Cassava Program	Completed
Developing NIRS equations to evaluate minerals in beans	María Luisa Cortés	CIAT's Bean Program, CIP	In process; manuscript in preparation
Evaluation of the phytate concentration of rice lines	Dayron Gutiérrez, Darwin Ortiz	CIAT's Rice Program	Initiated, in process
Evaluation of the <i>in vitro</i> iron bioavailability of rice lines	Ingrid Aragón	CIAT's Rice Program	Initiated, in process
NIRS analysis of 600 F1 cassava clones to develop calibration curves for crude protein	Darwin Ortiz, Teresa Sánchez	CIAT's Cassava Program	Initiated, in process
NIRS evaluation of the carotenoid concentration of 80 high-carotenoid cassava clones	Darwin Ortiz, Teresa Sánchez	CIAT's Cassava Program	Initiated, in process
NIRS carotenoid-concentration evaluation of 350 F1 yellow-fleshed cassava clones	Darwin Ortiz, Teresa Sánchez	CIAT's Cassava Program	Initiated, in process
Tolerance to post-harvest physiological deterioration in cassava roots	Teresa Sánchez, Darwin Ortiz	CIAT's Cassava Program	Completed; manuscript accepted in Crop Science
Evaluación del contenido de carotenoides en dos plantas de 80 clones de alto contenido de carotenoides a los 8, 10 y 12 meses de edad de la planta y 350 clones F1	Darwin Ortiz, Teresa Sánchez	CIAT's Cassava Program	Completed; manuscript submitted to the Journal of Food Composition and Analysis
Evaluation of anti-oxidant activity and its relationship to polyphenols in <i>musa paradisiaca</i>	Lizbeth Lorena López Parra	Dayron Gutiérrez, Corporación Biotec, Universidad del Valle	Initiated, in process

Annex 10. Presentations of Laboratory findings from January 2008 to January 2010.

Event	Place	Date	Authors	Presentation Title
Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos y Animales (PCCMCA)	San José, Costa Rica	14-18 April 2008	Darwin Ortiz, Helena Pachón, Cristina Araujo, Matthew Blair, José Restrepo	Biodisponibilidad de nutrientes en comidas preparadas con cultivos nutricionalmente mejorados de frijol y maíz*
Congreso Panamericano de Semillas	Cartagena, Colombia	14-17 October 2008	Dayron Gutiérrez, Darwin Ortiz, Helena Pachón	Análisis de calidad nutricional y biodisponibilidad de nutrientes en semillas, cultivos y alimentos: Una herramienta en pro de la nutrición humana en Latinoamérica
Congreso Panamericano de Semillas	Cartagena, Colombia	14-17 October 2008	Darwin Ortiz, Dayron Gutiérrez, Helena Pachón, Matthew Blair, Cristina Araujo, José Restrepo	Evaluación de la calidad proteica de platos preparados con cultivos de maíz mejorados nutricionalmente
Congreso Panamericano de Semillas	Cartagena, Colombia	14-17 October 2008	Darwin Ortiz, Dayron Gutiérrez, Helena Pachón, Matthew Blair, Cristina Araujo, José Restrepo	Evaluación del valor nutricional de micronutrientes en una receta típica (frijol sancochado) preparada con frijoles nutricionalmente mejorados
I Congreso Internacional, XI Nacional & Olimpiadas Académicas y Deportivas Universidad de Santander Sede Valledupar	Valledupar, Colombia	24 April 2009	Darwin Ortiz	Investigaciones de alimentos en pro de la nutrición humana: Ejemplo cultivos biofortificados dentro del marco del Proyecto AgroSalud
CIAT Knowledge-sharing Week and Board of Trustees Meeting	Palmira, Colombia	18-29 May 2009	Dayron Gutierrez, Darwin Ortiz, Helena Pachón	Nutrition Quality Laboratory: Projects and developments
CIAT Knowledge-sharing Week and Board of Trustees Meeting	Palmira, Colombia	18-29 May 2009	Ingrid Aragón Darwin Ortiz, Helena Pachón	Validación de un Método de Digestión <i>in Vitro</i> para la Evaluación de Biodisponibilidad de Hierro en alimentos
Congreso Iberoamericano de Ingeniería de Alimentos.	Bogotá, Colombia	6-9 September 2009	Aragón I, Ortiz D, Pachón H	Validación de un método de digestión <i>in vitro</i> para la evaluación de la biodisponibilidad de hierro en alimentos
Congreso Iberoamericano de Ingeniería de Alimentos. Colombia.	Bogotá, Colombia	6-9 September 2009	Paola Imbachí, Dayron Gutiérrez, Darwin Ortiz, Helena Pachón	Evaluación de la calidad proteica de recetas típicas del departamento del Cauca-Colombia elaboradas con maíz común y con maíz biofortificado con más lisina y triptófano
Congreso Iberoamericano de Ingeniería de Alimentos.	Bogotá, Colombia	6-9 September 2009	Dayron Gutiérrez, Darwin Ortiz, Helena Pachón	Efecto del tratamiento fermentativo con una mezcla de mieles en la calidad proteica de alimentos cárnicos y lácteos

Event	Place	Date	Authors	Presentation Title
Congreso Iberoamericano de Ingeniería de Alimentos.	Bogotá, Colombia	6-9 September 2009	Paola Imbachí, Dayron Gutiérrez D, Darwin Ortiz, Helena Pachón	Evaluación de la calidad proteica de recetas típicas del departamento del Cauca-Colombia elaboradas con maíz común y con maíz biofortificado con más lisina y triptófano
15th Triennial Symposium of the Intl. Society for Tropical Root Crops	Lima, Perú	2-6 November 2009	Fernando Calle, Hernán Ceballos, Alba Lucía Chávez, Darwin Ortiz, Constantino Cuambe, Chiedozie Egese, Martín Fregene, Nelson Morante, Juan Carlos Pérez, Amparo Rosero, Teresa Sánchez, Ximena Moreno, Adriana Tofiño	Identification of different sources for tolerance to post-harvest physiological deterioration in cassava
15th Triennial Symposium of the Intl. Society for Tropical Root Crops	Lima, Perú	2-6 November 2009	Nelson Morante, Teresa Sánchez, Darwin Ortiz, Alba Lucía Chávez, Fernando Calle, Hernán Ceballos	Progress increasing carotenoids content in cassava roots
15th Triennial Symposium of the Intl. Society for Tropical Root Crops.	Lima, Perú	2-6 November 2009	Nelson Morante, Teresa Sánchez, Darwin Ortiz, Alba Lucía Chávez, Isabel Ximena Moreno, Jorge Iván Lenis, Juan Carlo Pérez, Hernán Ceballos	Effect of age of the plant in total carotenoids content in cassava roots
15th Triennial Symposium of the Intl. Society for Tropical Root Crops	Lima, Perú	2-6 November 2009	Alba Lucía Chávez, Teresa Sánchez, Darwin Ortiz, Nelson Morante, Juan Carlos Pérez, Fernando Calle, Luis Augusto Becerra, Hernán Ceballos	Progress in developing a system for direct and simple measurement of protein content in cassava roots
15th Triennial Symposium of the Intl. Society for Tropical Root Crops	Lima, Perú	2-6 November 2009	Moralba Domínguez, Alba Lucía Chávez, Darwin Ortiz, Teresa Sánchez, Nelson Morante, Juan Carlos Pérez, Fernando Calle, Isabel Ximena Moreno, Hernán Ceballos, Luis Augusto Becerra	Variation in carotenoids content in roots from the same plant and plants from the same cassava genotype
XIII Congreso Colombiano de Nutrición y Dietética	Barranquilla, Colombia	12-14 November 2009	Darwin Ortiz, Sayda Pico, Helena Pachón, C. Chureeporn, Mark Failla	Evaluación de la bioaccesibilidad de extractos foliares de frijol, yuca, batata y alfalfa
XIII Congreso colombiano de dietistas y nutricionistas	Barranquilla, Colombia	12-14 November 2009	Sayda Pico, Dayron Gutiérrez, Ingrid Aragón, Andrés Escobar, Darwin Ortiz, Teresa Sánchez, Paola Imbachí, Helena Pachón	Evaluación del valor nutricional de diferentes extractos foliares

Event	Place	Date	Authors	Presentation Title
XIII Congreso colombiano de dietistas y nutricionistas	Barranquilla, Colombia	12-14 November 2009	Imbachi P, Gutiérrez D, Ortiz D, Pachón H	Evaluación de la calidad proteica de recetas típicas del departamento del Cauca-Colombia elaboradas con maíz común y con maíz biofortificado con más lisina y triptófano
XV Congreso Latinoamericano de Nutrición	Santiago de Chile, Chile	15-19 November 2009	Darwin Ortiz, Sayda Pico, Helena Pachón, C. Chureeporn, Mark Failla	Evaluation of carotenoid bioaccessibility in bean, cassava, sweet potato and alfalfa foliar extracts

Annex 11. Visitors to the Laboratory from January 2008 to January 2010.

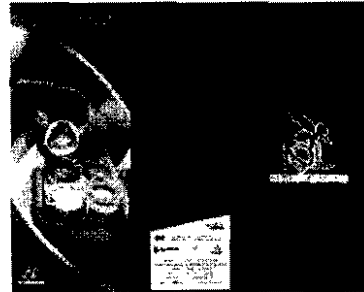
Year	Institution	Number of visitors
2008	Presidents, Municipality Associations of Florida, Pradera and Palmira, Department of Valle del Cauca	5
2008	Nutritionists from the Valle del Cauca food company <i>Alimentos NRC</i>	3
2008	Director General and other personnel from the <i>Corporación Autónoma Regional del Valle del Cauca (CVC)</i> , the Valle del Cauca governmental agency charged with environmental issues	9
2008 (Lab inauguration)	Researchers from the Universidad del Valle and Universidad Nacional de Colombia-Palmira, representatives from city (Cali, Palmira) and department (Valle del Cauca) health and agriculture ministries, the Colombian Institute for Family Wellbeing (<i>Instituto Colombiano de Bienestar Familiar</i>), the Valle del Cauca Association of Agricultural Engineers (<i>Asociación de Ingenieros Agrónomos del Valle del Cauca</i>), the Valle del Cauca governmental agency charged with environmental issues (<i>Corporación Autónoma Regional del Valle del Cauca</i>), members of the media, a representative from Burson-Marsteller, and CIAT staff	~50
2008 (CIAT's Open House)	Professors and students from the following Colombian institutions: Universidad Nacional de Colombia, Sede Palmira; Universidad de la Amazonia; Universidad Autónoma de Occidente – Cali; Instituto Técnico Agrícola – Buga; Universidad Central del Valle – Tuluá; SENA – Santander de Quilichao; Universidad del Valle – Caicedonia; Universidad del Tolima	149
2008	Centro de Investigación y Desarrollo Cárnico	2
2008	Almacenes La 14	6
2008	Secretaría de Agricultura del Valle del Cauca	8
2008	Secretaría de Agricultura y Salud de Palmira	3
2008	Programa RESA y Acción Social de la Presidencia	2
2008	Vallenpaz	15
2008	Fundación Carvajal	5
2008	Universidad Nacional de Colombia-Bogotá	2
2008	Universidad San Buenaventura	2
2008	Universidad del Pacífico	2
2008	CIAT's Board of Directors	7
2008	Monsanto's Head of Research and Development	1
2009	Centro de Investigaciones, Escuela de Nutrición y Dietética, Universidad de Antioquia	2
2009	Caldono (Cauca Department) community members, Municipal Ministries of Education and Agriculture, representatives of the Department's PANES program	~50
2009	Instituto Colombiano de Bienestar Familiar from Cauca Department	7
2009	Representatives from ADA Afro-Latino Development Alliance	5
2009	Delegation from the Nariño Governor's office	8
2009	CGIAR Executive Committee	6
2009	Escuela de Nutrición, Universidad de Antioquia	2
2009	MIT and UC Berkeley	1
2009	Ingeniería Agroindustrial de la Universidad del Cauca	40
2009	Ingeniería de Alimentos de la Universidad de Antioquia	43
2009	Central Agricultural Research Institute, India	1
	Total	~436

Annex 12. Communications pieces developed for the Laboratory from January 2008 to January 2010.

First Laboratory brochure, developed by Burson-Marsteller



Second Laboratory brochure developed in English



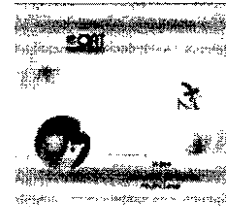
Second Laboratory brochure developed in Spanish



Summary of Laboratory's research activities



Video of the Laboratory's work, in Spanish



Laboratory keychain



Laboratory magnet



Laboratory bookmark

