Symposium "Cacao for Peace"
Mapping the Future of Cacao Research
for the Caribbean Region of Colombia

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ABSTRACTS OF LECTURES

CACAO RESEARCH PROJECTS IN ANTIOQUIA AS CONTRIBUTION FOR THE PROGRAM "CACAO FOR PEACE"

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Summary
Due to the growing demand and current world trend for cocoa and healthier products, Colombia has been promoting this crop as a strategy to position fine cocoa and aroma as the fourth world export product, as well as supporting research on new market niches on specific products of organic origin and functional confectionery for their high content of polyphenols, as well as the study of the beneficial substances of cacao. As part of this strategy, the Ten-Year Cacao Plan was created, which seeks to make Colombia a world-class player in the fine cocoa and aroma market. Under this prospective, Antioquia is expected to plant 25,500 new hectares and become the Department with the highest projection of area increase.
To achieve this, the Government of Antioquia signed an agreement with Fedecacao called "*Support for the strengthening of cocoa activity in the department by planting and sustaining cocoa crops and strengthening the regional committee of the cocoa-chocolate production chain*." This agreement seeks to implement 122 hectares of cocoa in 24 municipalities in the region, which will be financed with royalties. Through this project will also be given support to 2,306 hectares already established within a period of 3 years and thus ensure productivity. The Government of Antioquia, through the Secretary of Agriculture, has been supporting several research projects of this crop, additionally several Universities, Institutions, Corporations and the private company represented by the National Company of Chocolates. On the other hand, the National Government has been promoting a program called "*Cocoa for Peace*", aimed at supporting post-conflict populations, with the support of several countries and international institutions that have made their contributions to achieve through this crop, social and economic improvement of those actors who have been integrated into this process.
According to Fedecacao, "*There is a need to assist the cocoa families so that people in these regions have productive activities and reduce the socio-economic problems that exist,*" said the leader and explained that "during those 3 years people are going to Learn how to grow the product, select the seeds and the soil; but there is also a component related to adult crop care, which includes phytosanitary management".
During this presentation on Cacao Research Projects in Antioquia as a contribution for the Program **"Cacao for Peace"** the projects underway in this Department will be illustrated.

Overview of cacao research: Sustainable Perennial Crops Laboratory, of USDA-ARS

Bryan A. Bailey[a], V. C. Baligar[a], Dapeng Zhang[a], Osman Gutierrez[b], Lyndel W. Meinhardt[a]

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Summary

The Sustainable perennial Crops Laboratory (SPCL) carries out research on tropical perennial crop production systems of relevance to the United States of America. Currently the SPCL has three base funded projects principally studying cacao. Project 8042-21220-252-00D, Title: Genomic Characterization and Management of Fungal Diseases of Cacao is focused on the many serious diseases associated with cacao production. Currently the project focuses on black pod rot (*Phytophthora* species), frosty pod rot (*Moniliophthora roreri*), vascular streak (*Ceratobasidium theobromae*), and charcoal rot and tip blight (*Lasiodiplodia theobromae*) but also has a history studying witches' broom disease (*Moniliophthora perniciosa*). The SPCL supported the completion and release of the *M. perniciosa* draft genome and has led the sequencing of the *M. roreri*, *Phytophthora palmivora* and *Phytophthora megakarya* genomes. Peripheral studies have been carried out with each of these pathogens describing their genetic diversity and the biology of their interactions with cacao. Project 8042-21000-267-00-D, Title: Genetic Diversity Assessment of Cacao and Other Tropical Tree Crop Genetic Resources is focused on improve the management efficiency of and facilitate the use of germplasm of cacao and other tropical tree crops. Objectives of this project include the elucidation of geospatial patterns of genetic diversity in cacao and other tropical tree crops, the strategic acquisition of new cacao germplasm filling gaps in collections, and supporting in situ/on-farm conservation, and evaluation of cacao germplasm for host-plant resistance and other horticultural traits. Project 8042-21000-278-00D, Title: Sustainable Production Systems for Cacao is investigating cacao genotypes with superior ability for establishment under conditions of environmental stress (drought, light quality and soil acidity), characterizing the effects of cover crops on production potentials and bean quality and nutrient use efficiency in cacao, and developing long term environmentally sustainable cacao management systems that improve soil quality and yield. The Subtropical Horticulture Research Station (SHRS) in Miami, FL conducts research on subtropical tropical perennial crops cultivated in the continental and non-contiguous areas of the United States. At SHRS, Project 6038-21000-023-00-D, Title: Genetic Improvement of Cacao Through Genomics-Assisted Breeding is concentrated on the genetic improvement of cacao using genomic selection approaches. The project seeks to develop cacao with resistance to witches' broom, frosty pod, and black pod and with excellent horticultural and quality traits. Each project is dependent on multiple formal and informal international collaborations and new collaborations are welcome where interests are shared.

Diseases of cacao in Colombia: What we know and what we need to know.

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Summary

The Sustainable Perennial Crops Laboratory (SPCL) is heavily invested in the molecular characterization of cacao pathogens. Currently we are focused on black pod rot (*Phytophthora species*), frosty pod rot (*Moniliophthora roreri*), vascular streak (*Ceratobasidium theobromae*), and charcoal rot and tip blight (*Lasiodiplodia theobromae*). Over the past few years, the SPCL has supported the completion and release of the *M. perniciosa* draft genome and has led the sequencing and public release of the *M. roreri*, *Phytophthora palmivora,* and *Phytophthora megakarya* genomes. Through these studies, our understanding of the close genetic association between *M. perniciosa* and *M. roreri* has been strengthened. SNP analysis of regional *M. roreri* diversity verified Colombia as its likely center of origin and identified the Magdalena Valley as a location of high genetic diversity. Our research, along with that of others, validates Colombia as an area of particular interests when studying cacao resistance to frosty pod rot. *P. megakarya* and *P. palmivora* are also closely related species attacking cacao yet appear to have taken very different evolutionary paths. The *P. megakarya*/cacao interaction is clearly a new encounter. *P. megakarya* (a significant pathogen of cacao only) is particularly adapted to cacao, having proliferated its battery of genes managing the plants defense responses. *P. palmivora* (a broad host pathogen) is a functional tetraploid having doubled its genome size and consequently its entire gene compliment. Although it is unclear why, *Lasiodiplodia theobromae*, causal agent of charcoal rot and tip blight has continually been mentioned by collaborators as pathogen of interest in recent years. *L. theobromae* is distributed around the world and is commonly isolated in association with unusual blight events. We have recently acquired a genome sequence for *L. theobromae* isolated from cacao and are completing its analysis. Although we know a great deal about the pathogens of cacao, there remains much we do not know. Clearly, the *Moniliophthora* species and *Phytophthora* species causing disease on cacao are of importance to Colombia. The proposed project provides a unique opportunity to coordinate analysis of pathogen diversity within Colombia with efforts at selecting/breeding for disease resistance against multiple pathogens of cacao. Outcomes from these efforts will provide some assurance against the breakdown of resistance once new materials are released to farmers, something critical to sustainable production cacao.

Cadmium Issues in Cacao Cropping Systems

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Summary

Export of cocoa beans is an important value chain commodity for Colombia. Invariably cocoa beans from Colombia have high levels of Cd mainly because soils under cacao in Colombia tend to have high levels of Cd. European Union (EU) is proposing stricter regulations for Cd levels in imported cocoa beans and such regulation will become a trade barrier for sale of cacao beans from Colombia. Elevated levels of cadmium (Cd) in cacao beans reduce their quality and marketability and have negative impact on export earnings. Development of amendment based remediation technology will significantly and measurably reduce the bioavailability and chemical mobility of Cd in soils. Identifications of cacao genotypes capable of reduced accumulation of Cd and coupled with adaptation of effective soil amendment technology will improve chances of producing high quality cocoa beans with less Cd contamination and further this will improve marketability of cocoa beans in international trade. Various issues relating to Cd in soil-plants of cacao farming systems will be presented along with possible remediation methods to minimize bio-available soil Cd and selection of cacao genotypes for tolerance to Cd and reduce uptake of Cd.

How Colombia can become a world-level cacao production center

Aaron Beydoun
CEO, Fenicia Trading

Summary

This presentation will discuss real-world experiences from actual commodity merchants on some of the necessary requisites to build a profitable and self-sufficient cacao sector in Colombia. There is chronic underinvestment in the sector, productivity remains stubbornly low, and there is an uneven distribution of resources along the supply chain.
To assure the success of public and private initiatives in Colombia, the country needs to complement extension with the development a real internal market structure based on transparent price discovery and tested commercial expertise in global export markets. Even more, what is the role and responsibility of each stakeholder — government, regulator, producer, exporter — to ensure that we create a self-sufficient industry that is reliant exclusively on its own internal profits and not government aid. And finally, what is the integrated strategy of the various stakeholders in Colombia - should the country focus solely on fine flavor cacao for niche export markets or should Colombia offer global markets a diversified portfolio of cacao.

Genomics of Cacao Disease Resistance

Mark J. Guiltinan, Andrew S. Fister and Siela N. Maximova

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Summary

Plant genomes encode thousands of genes involved in disease resistance (the plant immune system). We are using genomic, functional genomic and metabolomics approaches to study the plant immune system of cacao. The immune system consists of proteins that function to sense the presence of pathogens (receptors), a series of signal transduction pathways that functions to integrate and amplify the signals from the receptors and a set of genes that respond to the signals which function to directly inhibit the pathogen infection process through a multitude of mechanisms (PR or Pathogenesis Related Proteins). We have identified a large number of genes encoding proteins in all three of the components of the cacao immune system and have begun to characterize their expression patterns and functions using a suite of functional genomics approaches. More recently, we have begun to explore the metabolites synthesized in response to pathogens to discover specific molecules with antibiotic activities against major cacao pathogens. The main objective of this work is to discover genes and pathways critical for pathogen resistance to set the stage for guiding more efficient breeding programs utilizing a wider array of genetic diversity. A secondary objective is to build genomics research capacity in cacao producing countries through support scientific exchanges and postdoctoral, graduate and undergraduate student training.

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Research results of the main causal agents of cacao diseases in Colombia and its projection

Yeirme Yaneth Jaimes Suárez, University of Pamplona.

Summary

In the context of the development of the titled project "Strategies for integrated management of the main pests and diseases of the cocoa cultivation", research activities were carried out to generate knowledge of main pest insect and pathogens populations in Colombia, followed by the validation of different strategies to their control. Among the most relevant results generated are: 1- Differentiation of the population structure of *M. roreri* in two groups associated by their origin; 2 - Generalized linear models with quasi-poisson distribution with logarithmic ligation function for the *M. roreri* and *Phytophthora palmivora* epidemics; 3- Spatial autocorrelation of monilia epidemics, evidencing the need to generate recommendations on the cocoa materials distribution in the plot and localities according to their resistance, microenvironments and terrain topography; 4- Differentiation of the enzymes guaiacol peroxidase (PPO) and Phenol-Oxidase (POX) activities according to their resistance to the black pot rot, indicating their potential use as biochemical markers for the cocoa materials selection for resistance; 5- According to commercial products efficacy in disease control, the Antrasin® and Manzate® were selected to be integrated into the management strategies of *P. palmivora* and Nativo® and Amistar Top® products for the control of *M. roreri,* due to its curative and protective activity up to 21 days after spraying; 6 - In the evaluation of biocontrollers, the strain *Bacillus subtilis* Bs006 was selected for its effectiveness both in the reduction of monilia incidence and the severity, which should be evaluated in additional production cycles under an integrated crop management; 7- For the monitoring of *Carmenta foraseminis* populations, the McPhail traps with hydrolyzed protein were selected as the most efficient method; and 8- Due the highest levels of damage by *C. foraseminis* occur in the higher precipitation period, was suggest a close relationship between the precipitation levels and the adults catches, and their aggregate distribution was associated with sites with higher relative humidity and shady level. Based on these results, we are currently working on the evaluation of different control methods, considering the knowledge generated, and to validate the integrated pest and disease management strategies in cocoa crop.

Building a platform for Microbial pathogenomics studies of the major cacao diseases in Latin America"

Jean-Philippe Marelli, Dario Cantu, Bryan Bailey, Lyndel Meinhardt

Summary

One of the most important challenges in cocoa breeding programs is improving resistance to the multitude of pathogens that threaten the crop. The increasing demand for cocoa in the world requires the development and implementation of new effective strategies to reduce losses caused by diseases (estimated to about 800,000 t/year). In addition to a vital influx of novel sources of resistance in breeding programs, functional characterization and deployment of durable resistance strategies need to be considered carefully. There is still little known about the diversity of cocoa pathogens in specific regions. Such studies could really be accelerated by having a comprehensive genome sequence database. In addition, diagnostic tools are necessary to be able to identify epidemics early on and also to certify that planting material is disease-free in cocoa quarantine greenhouses (Reading, Miami). Finally there is a need to increase the knowledge on the biology of those pathogens, and particular their effectors, which could lead to better resistance strategies in breeding programs. In this context, sequencing the main cacao pathogen genomes and transcriptomes, as well as the re-sequencing of multiple isolates of the same pathogen, can bring a valuable contribution to cocoa breeding.

Role of the Universidad Nacional de Colombia in strengthening the cacao chain value in the Country.

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Summary

The Universidad Nacional of Colombia, UNAL, was founded in 1867, it is a public university belong to the State and it´s the largest one in the Country with more than 44.000 students (40,000 undergraduate students and 4,000 a graduate students), 430 academic programs, which includes 96 graduate diplomas, 67 academic specializations, 36 medical specialties, 161 Masters degrees, 58 doctorates, and 931 research groups. It has eight campuses (Bogotá, Medellin, Manizales, Palmira, Leticia, San Andrés, Arauca and Tumaco) and the UNAL is number 9 in the QS ranking of universities in Latin America. The Role of the UNAL in strengthening the Agriculture Research has a tremendous impact in the country providing professionals with training of the high level in order to develop scientific knowledge and contribute to the solutions of problems of the agriculture sector. In Colombia, cacao cultivation is an important crop, particularly, to smallholder's farmers (3.3.ha on average) and represents an opportunity to improve life quality of small cacao farmers and increase levels of cacao export in the country. Indeed, cacao cultivation has been considered as one of the viable productive alternatives for post-conflict era and for the substitute of illicit crops. However, it is necessary to overcome the main agronomic limitations of the crop. These are related to productivity and competitive aspects, including the age of planting materials (mainly hybrids, with 60% of them over 20 years), low yield (0.5t.ha-1), low densities (less than 1000 pl.ha-1) and susceptibility to diseases. Moreover, there is poor management of agroforestry systems and processing of the grain. In order to increase productivity in a sustainable way, it is necessary to strengthen each of the links in the cacao value chain, which includes the establishment of the crop, harvest and benefits the development of socio-economic, political and legal aspects of the chain. For these reasons, it is a priority to begin work in education, research, production and promotion of the cacao value chain at the national level. The aim of this seminar is to present the interdisciplinary work that the Faculty of Agriculture Science has been carrying out in order to increase competitiveness of the cacao crop in Cundinamarca (Yacopí and Nilo), through a technological improvement of production on small-scale farming systems, and to present the new projects related with cacao genetic diversity, eco-physiology and fruit quality; plant nutrition and soil fertility; and cacao diseases and pests and their biological control.

Soil acidity correction and its importance in the development of cacao seedlings

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Summary

Soils are considered strongly acidic when the pH level is below 5.5, a condition under which the ionic species of Aluminum are available for the plants in the soil solution, generating limits for the plants. In Colombia, it has been estimated that 80-85% of the soils are acid; thus, it is necessary to evaluate the application of different amendments in soil pH correction and the development of cocoa seedlings.

This research was carried out at Granja Yariguíes (Barrancabermeja, Santander), using seed for patronage (IMC-67 x CAU-39) planted in a soil from a cocoa farm with a pH of 4.81, under greenhouse conditions. (T1) Calcium carbonate 22.1 t / ha, (t2) Magnesium silicate 22.1 t / ha, (t3) Magnesium carbonate 18.6 t / ha, (t4) Calcium hydroxide 16.0 ton / ha and (t5) Calcium and magnesium hydroxide 14.8 ton / ha, were applied superficially to the soil. 1 month later soil pH was evaluated at three depths (0-7, 7-14 and 14-21 cm) and seedlings of 15-day-old cacao were planted. After 4 months, biometric parameters such as stem diameter and length, root length and biomass were measured and pH was measured again. The results found for the correction of acidity in soils 0-7 cm deep showed that the pH increase was not maintained for the magnesium silicate treatment 4 months after application (pH at 1 month 5.11, at 4 months PH 4.87), and this decrease was equal to the decrease found in the control (pH at 1 month 4.81, at 4 months pH 4.36). pH increased in the other treatments. pH was maintained in time (pH at 1 month 5.73, at 4 months pH 5.59) for the depth of 7-14 cm in the treatment with Calcium carbonate, whereas for calcium hydroxide and magnesium increase (pH at 1 month 4.84, at 4 months pH 5.63); the pH decreased in the other treatments. At a depth of 14-21, cm the pH decreased for all treatments. The biometric parameters of the plants did not present significant differences. The results in general show effectiveness in increasing the pH for the 0-7 cm depth.

Juan Carlos Arroyave Giraldo
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Unesp Jaboticaba
CASA LUKER

Summary

The commercial approach of casaluker in the international market is based on the development of derivatives of fine flavor and aroma cacao, over almost 10 years of presence in the market has been recognized for the development of products based on cocoa and Research in Colombian fine cacao, which has allowed its presence in 27 countries and three continents. Research has been an important bulwark for commercial development and has been approached under two aspects:
* Evaluation and selection of fine aromatic cocoa varieties with good agronomic performance
* Sensorial and chemical characterization of individual varieties and mixtures present in the cacao-producing territories in Colombia
The two aspects allowed casaluker to come up with a proposal for a cacao plantation model under agroforestry systems, while allowing sustainability and thereby ensuring quality and profitability for producers.
This presentation describes the research processes with high specialization such as the cocoa genome and the aromatic chemical characterization, thus underpinnig the value proposition of Casa Luker to the cocoa sector of Colombia and the world.

Research results of the main agents causing cacao diseases in Colombia, and projection thereof

Yeirme Yaneth Jaimes Suárez
University of Pamplona.

Summary
In the context of the development of the titled project "Strategies for integrated management of the main pests and diseases of the cocoa cultivation", research activities were carried out to generate knowledge of main pest insect and pathogens populations in Colombia, followed by the validation of different strategies to their control. Among the most relevant results generated are: 1- Differentiation of the population structure of *M. roreri* in two groups associated by their origin; 2 - Generalized linear models with quasi-poisson distribution with logarithmic ligation function for the *M. roreri* and *Phytophthora palmivora* epidemics; 3- Spatial autocorrelation of monilia epidemics, evidencing the need to generate recommendations on the cocoa materials distribution in the plot and localities according to their resistance, microenvironments and terrain topography; 4- Differentiation of the enzymes guaiacol peroxidase (PPO) and Phenol-Oxidase (POX) activities according to their resistance to the black pot rot, indicating their potential use as biochemical markers for the cocoa materials selection for resistance; 5- According to commercial products efficacy in disease control, the Antrasin® and Manzate® were selected to be integrated into the management strategies of *P. palmivora* and Nativo® and Amistar Top® products for the control of *M. roreri,* due to its curative and protective activity up to 21 days after spraying; 6 - In the evaluation of biocontrollers, the strain *Bacillus subtilis* Bs006 was selected for its effectiveness both in the reduction of monilia incidence and the severity, which should be evaluated in additional production cycles under an integrated crop management; 7- For the monitoring of *Carmenta foraseminis* populations, the McPhail traps with hydrolyzed protein were selected as the most efficient method; and 8- Due the highest levels of damage by *C. foraseminis* occur in the higher precipitation period, was suggest a close relationship between the precipitation levels and the adults catches, and their aggregate distribution was associated with sites with higher relative humidity and shady level. Based on these results, we are currently working on the evaluation of different control methods, considering the knowledge generated, and to validate the integrated pest and disease management strategies in cocoa crops.

Diagnosis of cadmium levels in the soil and its distribution in cacao leaves and beans grown in Nilo and Yacopí, Cundinamarca

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(1) Student at the School of Agricultural Sciences; 2 Professor at the School of Agricultural Sciences

Summary
Cadmium (Cd) is a heavy metal found in the soil at concentrations generally less than 1 mg / kg Cd, but may be up to 16 mg / kg Cd depending on the type of rock from which the soil develops. One factor that increases accumulation of Cd in the soil is the application of certain fertilizers and enhancers. Cacao is an accumulating plant of this heavy metal, and relatively high levels have been reported in beans from some countries of South America, such as Colombia, Ecuador and Venezuela. This research undertook to diagnose the levels of total and available cadmium in the soils of some cacao plantations in the municipalities of Nilo and Yacopí (Cundinamarca), and to establish their relation with the levels of the element in the plant tissue and With other soil variables. The results show a strong positive relationship between the total soil Cd and the available Cd, evaluated by DTPA extraction. The order of concentration of Cd in the vegetal tissue is: litter> leaf> testa and bean. Over 70% of the crops sampled in both municipalities produce beans with more than 0.6 mg Cd / kg. In the municipality of Yacopí, the presence of Cd in the soil is related to the parental – sedimentary – material, whereas the municipality of Nilo may have an additional anthropogenic influence, though the use of agroinsumos with important levels of cadmium, mainly the sources of phosphoric fertilization and calcareous amendments. The factors that are associated with plant availability and uptake of cadmium are pH, organic carbon, P, Zn and Mn. It is necessary to establish a mitigation plan that fits each production system and locality.

Research at the National Cocoa Federation

Oscar Dario Ramírez
Technical Manager at FEDECACAO

Summary

Fedecacao has been developing the research program for the cultivation of cacao for more than 25 years. At present, the association develops five research projects in different areas of knowledge such as disease management, evaluation of materials of high yield fertilization, quality and productivity. To this effect, we have designated an elite team and two laboratories (quality and phytopathology) located in San Vicente de Chucurí, Santander, and with the support of the 21 branched across the country.

According to the current National Agenda for Research, Technological Development and Innovation, we are working on 13 topics. One of the main achievements of Fedecacao's research program is the delivery to the country of the highest quality cocoa propagation material. The clearest example of this was the registration of commercial cultivars of 8 clones carried out in December 2014. This is the result of a rigorous tree selection process, which were evaluated under agronomic and quality parameters. Regarding Monilia disease management, several evaluations are being carried out to find alternatives to control the disease. The evaluation of strategies for the reduction of cadmium content is being carried out through continuous training of the tasting panel.

Research results on the subject of genetic improvement through participatory selection

Nubia Martínez Guerrero; Edwin A. Gutierrez R.; Oscar D. Ramirez; Diannefair Duarte H; Edith Moreno M.; Oscar M. Gavanzo C.

Research Program, National Board of Colombian Cacao Producers – The National Cacao Fund

Summary

The genetic potential of cacao in Colombia – represented in genetic diversity – is national heritage and requires joint efforts for its rational study and exploration. The National Federation of Cocoa-FEDECACAO, through the strategy for recovery and conservation as well as evaluation of new promising clones (based especially on participatory breeding techniques as a basis for the recovery and safeguard of knowledge, genetic resources and social heritage) has Generated germplasm conservation processes and increased genetic diversity on farms, thereby promoting empowerment alongside farmers. Since the 1990s, FEDECACAO has begun the process of searching, selecting and evaluating outstanding trees on farms in all the producing regions of the country, with the participation of farmers in the selection of their best trees. As of the year 2016, the Federation has selected 116 trees from 40 municipalities in 12 departments including the Caribbean region. The experimental design used was BCA, in rows of fifteen plants registering ten trees of each clone by locality. We evaluated 22 qualitative and quantitative descriptors such as yield, response to monilia and quality in different environmental conditions, in cocoa producing areas. Clones with outstanding characteristics were established and the components of yield, response to diseases and components of grain quality were evaluated during six years. The data obtained in the evaluation were analyzed using descriptive and multivariate statistics. The results obtained allowed to conclude that the wide genetic diversity of cacao in Colombia should continue being used in the selection of genotypes with special characteristics. In 2014, the commercial registry was obtained for 8 new cacao genotypes and they possess characteristics of high yield, greater tolerance to *monilia* and sensorial quality, while Fedecacao continues working in the selection of genotypes of interest for the increase of the productivity and incentivizing new selections of promising materials with fine flavor and fine aroma cacao characteristics.

Zoning for commercial cacao crops (*Theobroma cacao*), scale 1: 100,000
Fidel Londoño Stipanovic

Summary

This research undertook to elaborate a map to identify areas suitable for the establishment of commercial cacao plantations at a 1:100.000 scale, determining areas with high, medium, low aptitude, and zero aptitude for crop establishment.
The zoning activity is based on the principles of the Land Assessment Scheme (FAO, 1976), Land Assessment Guidelines and Guidelines for Agriculture (FAO, 1985), and the parallel-stage approach to integration and analysis of the physical, Socio-economic and ecological components, as proposed under the Framework for Land Evaluation (FAO, 2007). Within the FAO land assessment scheme, the definition of land units and crop requirements is required, accompanied by a multi-criteria assessment to align it with the current processing availability, grading and data standardization tools, in order to generate stronger results as compared to other procedures.
The methodology is based on the development of three (physical, socio-ecosystemic and socio-economic) components, which are formed into criteria and composed of characterization variables. A criterion is regarded as "the set of requirements, parameters or variables that define decisions of aptitude of specific use of a rural territory".

The multicriteria evaluation is a method designed to value several criteria, in a structured way, regarding a criterion as the basis for a decision that can be measured or evaluated, which in this particular case, are physical, socio-economic and socio-economic strategic options. This evaluation involves using the AHP Hierarchical Analytical Process (Thomas Saaty), to formalize the intuitive understanding of complex problems by constructing a hierarchical model. This method allows the experts consulted to be able to structure a multi-criteria problem in a visual way, through the construction of a hierarchical model.

With the above, it is necessary to elaborate a cartographic model to represent in maps each criterion with the information on zones apt and not suitable for the development of the crop. This involves the use of spatial analysis tools, which run on layers of information to produce a new layer. This model has the following initial inputs: the maps per criterion for each component, the exclusions and legal constraints and the integration of all the layers, weighting their value in accordance with the result of the multicriteria analysis.

22 (9 physical, 5 socioeconomic and 8 socioeconomic) criteria were identified to produce the cacao aptitude zoning map, which resulted in a total of 19,195,073 ha (16.8%), of which 4,785,734 Ha (4.2%) are A1 (high), 9,691,757 ha (8.5%) A2 (average) and 4,717,582 ha (4.1%) A3 (Low).