Paulo Izquierdo

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EDUCATION

2023 Ph.D., Plant Breeding, Genetics, and Biotechnology – Crop and Soil Sciences, Department of Plant, Soil, and Microbial Sciences, Michigan State University, East Lansing, MI.

2022 Graduate certificate, Computational Plant Science, Department of Plant Biology, Michigan State University, East Lansing, MI.

2010 B.S., Biology, Universidad del Tolima, Ibagué, Colombia.

RESEARCH AND PROFESSIONAL EXPERIENCE

03/2026-Present **Assistant Professor.** Plant breeding, phenomics and genomics. Department of plant and environmental sciences, New Mexico State University.

03/2023-03/2026 **Research Associate.** Investigate the genetic architecture of complex traits in plant species and incorporate these findings into genomic prediction models. Great Lakes Bioenergy Research Center, Michigan State University. **PI:** Shin-Han Shiu

01/2017-12/2022 **Graduate Research Assistant.** Explored the genetic architecture and improved genomic prediction accuracy for yield and end-use quality traits in dry bean. Department of Plant, Soil, and Microbial Sciences, Michigan State University. **PI:** Karen Cichy

06/2022-08/2022 **Quantitative Genetics / Computational Biology Intern**. Identified potential targets for genome editing using machine learning. INARI.

06/2016-12/2016 **Visiting Scholar.** Developed molecular markers linked to anthracnose resistance in dry bean. Department of Plant, Soil, and Microbial Sciences, Michigan State University. **PI:** James Kelly

09/2013-06/2016 **Research Assistant**. Uncovered the genetic architecture of the mineral concentration in dry bean using GWAS and QTL approaches in a Multiparent Advance Generation Intercross population. CIAT. **PI:** Bodo Raatz

01/2011-08/2013 **Research Assistant.** Identified genomic regions associated with agronomic traits in sugarcane. Colombian Sugarcane Research Center (Cenicaña). **PI:** Jershon Lopez

07/2010-12/2010 **Visiting Researcher.** Implemented marker-assisted selection for resistance to anthracnose in dry bean. CIAT/Universidad Nacional de Colombia. **PI:** Matthew Blair

01/2009-06/2010 **Undergraduate Research Assistant.** Evaluated the use of wild germplasm to increase the mineral concentration in cultivars of common beans. CIAT. **PI:** Matthew Blair

PUBLICATIONS

Google Scholar

*Authors contributed equally

2026 **Izquierdo P**, Weng X, Juenger T, Bonnette J, Yoshinaga Y, Daum C, Lipzen S, et al. Uncovering genetic mechanisms underlying trait variation in switchgrass using explainable artificial intelligence. bioRxiv.   https://doi.org/10.64898/2026.03.06.710154

2025 Segura K, **Izquierdo P**, de Los Campos G, Lehti-Shiu M, Shiu S. Predictive models of the genetic bases underlying budding yeast fitness in multiple environments. bioRxiv. https://doi.org/10.1101/2025.10.20.683436

2025 Singhal R[*], **Izquierdo P**[*], Ranaweera T, Segura K, Brown B, Lehti-Shiu M, Shiu S. Using supervised machine-learning approaches to understand abiotic stress tolerance and design resilient crops. *Phil. Trans. R. Soc. B*. https://doi.org/10.1098/rstb.2024.0252

2025 **Izquierdo P**, Wright E, Cichy K. GWAS-Assisted and multi-trait genomic prediction for improvement of seed yield and canning quality traits in a black bean breeding panel. *G3 Genes|Genomes|Genetics*. https://doi.org/10.1093/g3journal/jkaf007

2025 Palande S, Arsenault J, Basurto P, Bleich A, Brown B, Buysse S, Connors N, Adhikari S, Dobson K, Guerra F, Guerrero M, Harlow S, Herrera H, Hightower A, **Izquierdo P**, et al. Expression-based machine learning models for predicting plant tissue identity. *Applications in Plant Sciences*. https://doi.org/10.1002/aps3.11621

2024 **Izquierdo P**, Sadohara R, Wiesinger J, Glahn R, Urrea C, Cichy K. Genome-wide association and genomic prediction for iron and zinc concentration and iron bioavailability in a collection of yellow dry beans. *Front. Genet*. 15, 1-12. https://doi.org/10.3389/fgene.2024.1330361

2023 **Izquierdo P**, Kelly J, Beebe S, Cichy K. Combination of meta-analysis of QTL and GWAS to uncover the genetic architecture of seed yield and seed yield components in common bean. *The Plant Genome,* 16, e20328. https://doi.org/10.1002/tpg2.20328

2023 Amongi W, Nkalubo S, Ochwo-Ssemakula M, Badji A, Dramadri I, Odongo T, Nuwamanya E, Tukamuhabwe P, **Izquierdo P**, Cichy K, Kelly J, Mukankusi C. Phenotype based clustering, and diversity of common bean genotypes in seed iron concentration and cooking time. *PLOS ONE* 18(5): e0284976. https://doi.org/10.1371/journal.pone.0284976

2023 Amongi W, Nkalubo S, Ochwo-ssemakula M, Dramadri I, Odongo T, Nuwamanya E, Tukamuhabwe P, **Izquierdo P**, Cichy K, Kelly J, Mukankusi C. Genetic clustering, and diversity of African panel of released common bean genotypes and breeding lines. *Genet. Resour. Crop Evol*. 70, 2063–2076. https://doi.org/10.1007/s10722-023-01559-y

2022 Sadohara R, **Izquierdo P**, Couto Alves F, Porch T, Beaver J, Urrea C, Cichy K. The *Phaseolus vulgaris* L. Yellow Bean Collection: genetic diversity and characterization for cooking time. *Genet. Resour. Crop. Evol*. 69, 1627–1648. https://doi.org/10.1007/s10722-021-01323-0

2022 Sadohara R, Long Y, **Izquierdo P**, Urrea C, Morris D, Cichy K. Seed coat color genetics and genotype × environment effects in yellow beans via machine-learning and genome-wide association. *The Plant Genome* 15:e20173. https://doi.org/10.1002/tpg2.20173

2020 Diaz S, Ariza-Suarez D, **Izquierdo P**, Lobaton J, de la Hoz J, Acevedo F, Duitama J, Guerrero J, Cajiao C, Mayor V, Beebe S, Raatz B. Genetic mapping for agronomic traits in a MAGIC population of common bean (*Phaseolus vulgaris* L.) under drought conditions. *BMC Genomics* 21, 799. https://doi.org/10.1186/s12864-020-07213-6

2020 **Izquierdo P**, Lopez M, Kelly J, Cichy K. Assessing genomic selection prediction accuracy for yield and end-use quality traits in a black dry bean breeding population. *Annual report of the Bean Improvement Cooperative* 63.

2020 Berry M, **Izquierdo P**, Jeffery H, Shaw S, Nchimbi-Msolla S, Cichy K. QTL analysis of cooking time and quality traits in dry bean (*Phaseolus vulgaris* L.). *Theoretical and Applied Genetics* 133, 2291–2305. https://doi.org/10.1007/s00122-020-03598-w

2018   **Izquierdo P**, Astudillo C, Blair M, Iqbal A, Raatz B, Cichy K. Meta-QTL analysis of seed iron and zinc concentration and content in common bean (*Phaseolus vulgaris* L.). *Theoretical and Applied Genetics* 131, 1645–1658. https://doi.org/10.1007/s00122-018-3104-8

2018   **Izquierdo P**, Shaw S, Berry M, Cichy K. A saturated genetic linkage map of common bean (*Phaseolus vulgaris* L.) developed using Genotyping by Sequencing (GBS). *Annual report of the Bean Improvement Cooperative* 61.

2016   Perea C, De La Hoz J, Cruz D, Lobaton J, **Izquierdo P**, Quintero J, Raatz B, Duitama J. Bioinformatic analysis of genotype by sequencing (GBS) data with NGSEP. *BMC Genomics* 17, 498. https://doi.org/10.1186/s12864-016-2827-7

2013   Blair M, **Izquierdo P**, Astudillo C, Grusak M. A legume biofortification quandary: Variability and genetic control of seed coat micronutrient accumulation in common beans. *Front. Plant Sci*. 4, 1–14. https://doi.org/10.3389/fpls.2013.00275

2013   Delgado H, Pinzón E, Blair M, **Izquierdo P**. Evaluation of bean (*Phaseolus vulgaris* L.) lines result of an advanced backcross between a wild accession and Radical Cerinza. *U.D.C.A Act. & Div. Cient.* 16(1), 79–86. https://doi.org/10.31910/rudca.v16.n1.2013.861

2013   **Izquierdo P**, Gutierrez A, Victoria J, Angel J, Avellaneda M, Lopez J. Molecular markers associated with resistance to Sugarcane yellow leaf virus. *International Society of Sugar Cane Technologists* 28, 1179–1188.

2012   Blair M, **Izquierdo P**. Use of the advanced backcross-QTL method to transfer seed mineral accumulation nutrition traits from wild to Andean cultivated common beans. *Theoretical and Applied Genetics* 125, 1015–1031. https://doi.org/10.1007/s00122-012-1891

2011   Blair M, **Izquierdo P**, Astudillo C, Monserrate F, Cortés M, Avila P, Felde T, Pfieffer W. Utilization of near infrared spectrophotometry (NIRS) analysis for evaluation of mineral content in Andean bean samples. *Annual report of the Bean Improvement Cooperative* 57.

In preparation:

Ranaweera T, Lowry D, Lehti-Shiu M, Shiu S, **Izquierdo P**. Understanding the divergence of cold resistance between upland and lowland switchgrass ecotypes.

Mallidi T, Brown B, Segura K, **Izquierdo P**, Ranaweera T, Chiang S, Singhal R, Lehti-Shiu M, Shiu S. Representing Plant Science Literature as a Knowledge Graph.

SCIENTIFIC PRESENTATIONS

Invited talks:

2026   Machine learning to understand GxE, Systems biology and ontologies session. Plant & Animal Genome conference. January 9.

2022   Nutritional quality: an essential trait for new crop varieties. Webinar "Agriculture, biodiversity, and nutrition: foundations for sovereign, sustainable, and resilient food systems". Universidad Nacional de Colombia. April 22.

2021   Exploring the genetic architecture and improving genomic prediction accuracy for yield, mineral concentration, and canning quality traits in dry bean (*Phaseolus vulgaris* L.). Webinar "Phytopathology and plant breeding". Universidad de Nariño, Colombia. November 3.

2020   Use of molecular markers in dry bean breeding, Universidad Industrial de Santander, Colombia. June 24.

Contributed talks and posters:

2025   **Izquierdo P**, Segura K, Weng X, Juenger T, Lowry D, Shiu, S. Transcriptomic profiling reveals genotype-by-environment interactions influencing trait variation in switchgrass. Great Lakes Bioenergy Research Center, Annual Science Meeting. **Oral presentation.**

2024   **Izquierdo P**, Segura K, Weng X, Juenger T, Lowry D, Shiu, S. Unraveling the genetic landscape of biomass in switchgrass through transcriptomics. Plant Biology. **Poster.**

2024   **Izquierdo P**, Segura K, Weng X, Juenger T, Lowry D, Shiu, S. Uncover the genetic architecture of agronomic traits in a switchgrass diversity panel across two environmentally distinct locations: Michigan and Texas. Great Lakes Bioenergy Research Center - Annual Science Meeting. **Oral presentation.**

2019   **Izquierdo P**, Lopez M, Kelly J, Cichy K. Assessing genomic selection prediction accuracy for yield and end-use quality traits in black beans. Bean improvement cooperative. **Poster.**

2019   **Izquierdo P**, Katuuramu D, Cichy K. Genomic selection for nutritional traits and cooking time in common bean) using Genotyping by Sequencing. Plant & Animal Genome. **Poster.**

2019   Cichy K, Wiesinger J, Basset A, Sadohara R, **Izquierdo P**, et al. Optimizing the convenience, nutrition, and taste of yellow dry beans (Phaseolus vulgaris L.) to promote pulse consumption in the U.S. NAPB. **Oral presentation.**

2019   Sadohara R, **Izquierdo P,** Wiesinger J, Glahn R, Cichy K. Yellow Bean Collection (*Phaseolus vulgaris* L.) − genotypic diversity of cooking time and iron bioavailability. NAPB. **Poster.**

2018   **Izquierdo P**, Astudillo C, Iqbal A, Blair M, Raatz B, Cichy, K. Meta-QTL Analysis in Common Bean to Uncover the Genetic Architecture of Iron and Zinc Concentration in Seed. Plant & Animal Genome. **Poster.**

2017   **Izquierdo P**, Shaw S, Berry M, Cichy K. A saturated genetic linkage map of common bean developed using Genotyping by Sequencing (GBS). Bean Improvement Cooperative. **Poster.**

2016   **Izquierdo P**, Lobaton J, Mayor V, Grajales M, Cajiao C, Duitama, J, Raatz B. Genome-wide association mapping for yield and other agronomic traits in a Multi-parent advanced generation inter-cross population of Mesoamerican common bean *(Phaseolus vulgaris L.)*. IX Latin American and Caribbean Agricultural and Forestry Biotechnology Meeting. **Oral presentation.**

2016   De la Hoz J, Lobaton J, Perea C, Cruz D, Quintero J,   **Izquierdo P**, Raatz B. Development of NGSEP as an open-source comprehensive solution for analysis of high throuput sequencing data. Bioinformatics Open Source Conference. **Poster.**

2015   Lobaton J, **Izquierdo P,** Cajiao C, Grajales M, Polania J, Duitama J, Raatz B, Beebe S. QTL mapping on a multiparent advanced generation inter-cross (MAGIC) population for dry bean using genotype-by-sequencing (GBS). Plant & Animal Genome. **Poster**

2013   **Izquierdo P**, Gutiérrez A, Victoria J, Ángel J, López J, Avellaneda C. Molecular markers associated with resistance to the sugarcane yellow leaf virus. XXVIII International Society of Sugarcane Technologists (ISSCT). **Oral presentation.**

2012   **Izquierdo P**, Gutiérrez A, Victoria J, Ángel J, López J, Avellaneda C. Molecular markers associated with resistance to the sugarcane yellow leaf virus. IX Association for Sugarcane Technology in Latin America and the Caribbean (Atalac-Tecnicaña). **Oral presentation.**

2011   **Izquierdo P**, Gutiérrez A, Victoria J, Ángel J, López J, Avellaneda C. Molecular markers associated with resistance to the sugarcane yellow leaf virus. Colombian and Latin American Phytopathological Association. **Oral presentation.**

RESEARCH GRANTS

2025   Singhal R, Jenny S, **Izquierdo P. (Lead PI).** Deciphering heat stress response regulation in *Arabidopsis* through multi-gene targeting. Plant Resilience Seed Grant, Michigan State University ($10,000).

2024   **Izquierdo P**, Kromdijk Johannes, Schön C, Shiu, S, Weber A. Future-proofing maize to a changing climate by focusing on early plant growth. USDA-NIFA, UKRI-BBSRC, DFG, and NSF Trilateral Call: Future proofing plants to a changing climate. Reached final stage of review (Not Funded).

FELLOWSHIPS/ SCHOLARSHIPS/AWARDS

2025   Outstanding Reviewer, *The Plant Genome*. American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America.

2022   Norman and Jessie Thompson fellowship in Crop and Soil Sciences ($5,000).

2021   NSF Research Traineeship – Integrated training model in plant and computational sciences fellowship ($29,781).

2021   Everett and Jane Everson fellowship in Plant Breeding ($2,500).

2021   Jason and Dana Lilly fellowship in Plant Breeding, Genetics & Biotechnology ($1,500).

2021   Norman and Jessie Thompson fellowship in Crop and Soil Sciences ($4,000).

2021   College of Agriculture and Natural Resource fellowship, Michigan State University ($6,000).

2020   Bayer Diversity Initiative Scholar.

2019   Everett and Jane Everson fellowship in Plant Breeding ($2,500).

2019   Norman and Jessie Thompson fellowship in Crop and Soil Sciences ($1,000).

2019   Graduate student language fellowship in undergraduate teaching and learning. Residential College in the Arts and Humanities, Michigan State University ($4,000).

2019   Council of Graduate Students, Conference Award, Michigan State University ($300).

2018   The Crop and Soil Science Graduate Award, Michigan State University ($1,700).

2018   Jason and Dana Lilly fellowship in Plant Breeding, Genetics & Biotechnology ($1,500).

2018   Elmer C. Rossman fellowship in Plant, Soil & Microbial Sciences ($3,500).

2018   Everett and Jane Everson fellowship in Plant Breeding ($2,500).

2018   Resilient and Nutritious Dry Beans for Africa fellowship, USDA-FAS ($5,400).

2017   Doctoral Fellowship Program. COLCIENCIAS, Colombia's Administrative Department of Science, Technology, and Innovation ($120,000).

TEACHING EXPERIENCE

Michigan State University:

2019   Teaching Assistant: Department of Plant, Soil and Microbial Sciences, Introduction to Plant Genetics (CSS350), Michigan State University

2019   Spanish Language Assistant: Residential College in the Arts and Humanities, Program on Sustainability in Costa Rica, Michigan State University.

Workshops:

2024   "Introduction to Machine Learning", Great Lakes Bioenergy Research Center - Annual Science Meeting. Organizer and lecturer for 1-session workshop, 60 participants.

2023   "Introduction to Machine Learning", Universidad Industrial de Santander, Colombia. Organizer and lecturer for 2-session workshop, 32 participants.

2021   "Quantitative Genetics", MSU-Feed the Future Innovation Lab for Crop Improvement (Eastern Africa). Organizer and lecturer for 9-session workshop, 123 participants. https://pauloizquierdo.github.io/Quantitative_Genetics/

2021   "Quantitative Genetics", Universidad Industrial de Santander, Colombia. Organizer and lecturer for 1-session workshop, 52 participants. https://compasscol.github.io/2021B_talleres-UIS.html

2021   "Data visualization with R", Universidad Industrial de Santander, Colombia. Organizer and lecturer for 2-day workshop, 40 participants. https://compasscol.github.io/dataviz/

2021   "Introduction to R", Universidad Industrial de Santander, Colombia. Organizer and lecturer for 2-day workshop, 40 participants. https://compasscol.github.io/IntroR/

MENTORING

2025-2026   Thilanka Ranaweera, Ph.D. Michigan State University. Project: Cis and trans-regulatory mechanisms underlying cold resistance divergence in switchgrass ecotypes.

2024-2026   Kenia Segura-Abá, Ph.D. Michigan State University. Project: Impact of genetic variants and the environment on the prediction of yeast fitness.

2022-2023   Yuranis Miranda, M.Sc., Universidad Industrial de Santander, Colombia. Project: Genetic and Morphological Variability of *Vaccinium meridionale* Sw. Across the Central and Eastern Andean Regions of Colombia.

2021   Anisa Rashid, Undergrad researcher/hourly worker, Michigan State University. Project: Evaluation of canning quality in dry beans.

2018- 2020   Winnyfred Amongi, Visiting Scholar, Michigan State University. Project: High-throughput genotyping and genomic prediction in dry beans. *co-authored paper.*

2015-2016   Wilson Santiago, Biology Intern. International Center for Tropical Agriculture. Project: Genetic mapping for agronomic traits in a MAGIC population of common bean. *co-authored paper.*

2015-2016   Laura Paz, Biology Intern. International Center for Tropical Agriculture. Project: Fine mapping of regions associated with Fe concentration in dry bean.

STUDENT MENTORING COMMITTEES

2025   Hernán Maigual, MSc. Universidad de Nariño, Pasto, Colombia. Project: Variability Assessment of Fava Beans (*Vicia faba* L.) Originating from the Andean Region of Nariño, Colombia.

2023   Miguel Mendoza, Ph.D. Universidad Nacional de Colombia, Bogotá, Colombia. Project: Genetics of Nitrogen Use Efficiency in Plants.

2021   Diego González, MSc. Universidad Nacional de Colombia, Bogotá, Colombia. Project: Analysis of the Fungal Microbiome in Cocoa Soils with Varying Cadmium Concentrations.

2021   Emili Garcia, MSc. Universidad Nacional de Colombia, Bogotá, Colombia. Project: Identification of Allelic Variants and Assessment of Candidate Gene Expression Linked to Bacterial Vascular Wilt Resistance in Cassava.

2020   Fabián Villamil, MSc. Universidad Nacional de Colombia, Bogotá, Colombia. Project: Expression of the polyhydroxyalkanoate (PHA) synthase enzyme from *Aeromonas caviae* in transgenic tobacco, lead to the synthesis of a poly (4-hydroxybutyrate).

LEADERSHIP AND PROFESSIONAL SERVICE

Ad Hoc Funding Agency Reviewer Panel Activities:

    NSF Reviewer. 2026

Colombia's Administrative Department of Science, Technology, and Innovation. 2023

Manuscript Editor/Reviewer:

Associate Editor, *Plant Disease, American Phytopathological Society,* International. 2025-2026

Ad Hoc Manuscript Reviewer:

Agronomy (1), *Agronomy Journal* (1), *Communications Biology* (6), *Crop Science* (3), *G3:Genes, Genomes and Genetics* (1), *Genetics* (2), *GigaScience* (2), *Nature Communications* (2), *PhytoFrontiers* (1), *Plant Disease (5)*, *Scientific Reports* (1), *Theoretical and Applied Genetics* (1), *The Plant Genome* (7).

Conference/symposium organization:

2021   Co-Organizer, Workshops series focused on data analysis in biology and agriculture. Universidad Industrial de Santander, Colombia. https://compasscol.github.io/2021B_talleres-UIS.html

2021   Co-Organizer, Online seminar series on phytopathology and plant breeding. Universidad de Nariño, Colombia. https://compasscol.github.io/2021A_Conferencias-UNar.html

2020   Co-Founder, Community Platform for Agricultural Sciences (COMPASS). Website: https://compasscol.github.io/

2020   Co-Organizer, Ciencia en línea: impulsando el uso de plataformas para la divulgación, colaboración e inspiración científica, symposium, SOCOLEN

2019   Co-Organizer, Phenomic Application in Plant Breeding, Corteva-PBGB symposium.

OUTREACH AND CAPACITY BULDING

2025   Organizer and Presenter. Plant Genome Investigators. MSU Science Festival.

2020-2022   Scientist mentor. Genomic selection capacity building. NaCRRI and CIAT-Uganda.

2020   Presenter. Graduate Studies: Do's and Don'ts. Caribbean Microbial Meeting.

2019   Presenter. Dry bean field day. Michigan State University.

2018   Presenter. Dry bean field day. Michigan State University.

MEMBERSHIPS

American Society of Plant Biologists