

Paulo Izquierdo

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EDUCATION

- 2023 Ph.D., Plant Breeding, Genetics, and Biotechnology, 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

- 03/2023-Present Postdoctoral 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. Principal Supervisor: Shin-Han Shiu
- 01/2017-12/2022 Graduate Research Assistant. Exploring the genetic architecture and improving genomic prediction accuracy for yield and end-use quality traits in common bean. Michigan State University. Principal Supervisor: 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 common bean. Michigan State University. Principal Supervisor: Karen Cichy and James Kelly
- 09/2013-06/2016 Research Assistant. Uncovered the genetic architecture of the mineral concentration in common bean using GWAS and QTL approaches in a Multiparent Advance Generation Intercross population. CIAT. Principal Supervisor: Bodo Raatz
- 01/2011-08/2013 Research Assistant. Identified genomic regions associated with agronomic traits in sugarcane. Colombian Sugarcane Research Center (Cenicaña). Principal Supervisor: Jershon Lopez
- 07/2010-12/2010 Visiting Researcher. Implemented marker-assisted selection for resistance to anthracnose in common bean. CIAT/Universidad Nacional de Colombia. Principal Supervisor: Matthew Blair
- 01/2009-06/2010 Undergraduate Research Assistant. Evaluated the use of wild germplasm to increase the mineral concentration of cultivars in common beans. CIAT. Principal Supervisor: Matthew Blair

PUBLICATIONS

<https://scholar.google.com/citations?user=5sZkDtAAAAAJ&hl=en>

Peer-Reviewed Journal Articles:

- 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. and 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. and 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. and 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. and 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., and Cichy, K. Seed coat color genetics and genotype × environment effects in yellow beans via machine-learning and genome-wide association. 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. and 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 Berry, M., **Izquierdo, P.**, Jeffery, H., Shaw, S., Nchimbi-Msolla, S., and Cichy, K. QTL analysis of cooking time and quality traits in dry bean (*Phaseolus vulgaris* L.). TAG. 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>
- 2017 **Izquierdo, P.**, Shaw, S., Berry, M. and 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 60.
- 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 and **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 JI, Angel JC, Avellaneda MC, Lopez J. Molecular markers associated with resistance to Sugarcane yellow leaf virus. International Society of Sugar Cane Technologists 28, 1179–1188.
- 2012 Blair, M. W., & **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., Pfeiffer, 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.

Pre-prints:

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.**, Jacobs, M., Johnson, N., Leuenberger, W., Lopez, A., Luckie, A., Martínez, Mendoza, M., Plancarte, D., Schuster, J., Shomer, H., Sitar, S., Steensma, A., Thomson, J., Villaseñor, D., Waterman, R., Webster, B., Whyte, M., Zorilla, S., Montgomery, B., Husbands, A., Krishnan, A., Perciva, S., Munch, E., VanBuren, R., Chitwood, D and Rougon-Cardoso, A. 2023. A data-driven evaluation of Arabidopsis-centric research and the model species concept. bioRxiv.

In preparation:

Izquierdo, P; Kelly, J; Cichy, K. Accelerating genetic gain in dry beans for yield and end-use quality traits using genomic selection and high-throughput phenotyping.

SCIENTIFIC PRESENTATIONS

Invited talks:

- 2022 Nutritional Quality: An Essential Trait for New Crop Varieties, presented during the 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.). presented during the Webinar "Phytopathology and Plant Breeding". Universidad de Nariño, Colombia. November 3.
- 2020 Graduate Studies: Do's and Don'ts, presented at the "Caribbean Microbial Meeting". October 29.
- 2020 Use of molecular markers in dry bean breeding, Universidad Industrial de Santander, Colombia. June 24.

Contributed talks and posters:

- 2024 **Izquierdo, P;** Segura, K; Weng, X; Juenger, T; Lowry, D and 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 and 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.**
- 2018 **Izquierdo, P;** Astudillo, C; Iqbal, A; Blair, M; Raatz, B and 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 and 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 and 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, Peru. **Oral presentation.**

- 2013 **Izquierdo, P**; Gutiérrez, A; Victoria, J; C; Ángel, López, J; Avellaneda, C. Molecular markers associated with resistance to the sugarcane yellow leaf virus. XXVIII International Society of Sugarcane Technologists (ISSCT). Brazil. **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). Colombia. **Oral presentation.**
- 2011 **Izquierdo, P**; Gutiérrez, A; Avellaneda, C; Victoria, J; Ángel, López, J. Molecular markers associated with resistance to the sugarcane yellow leaf virus. Colombian and Latin American Phytopathological Association. Colombia. **Oral presentation.**

HONORS, AWARDS, AND FUNDING

- 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

- 2022 Yuranis Miranda, Graduate Research Assistant, 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 Winnyfred Amongi, Visiting Scholar, Michigan State University. Project: High-Throughput genotyping and genomic prediction in dry beans. *co-authored paper*.
- 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*.
- 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

- 2023 Miguel Mendoza, Ph.D. Universidad Nacional de Colombia, Bogotá, Colombia. Project: Genetics of Nitrogen Use Efficiency in Plants.
- 2022 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.
- 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)

PROFESSIONAL SERVICE

Ad Hoc Grant Reviewer:

- 2023 Colombia's Administrative Department of Science, Technology, and Innovation (Colciencias).

Ad Hoc Reviewer:

Scientific reports (1), GigaScience (2), Agronomy (1), PhytoFrontiers (1).

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.

MEMBERSHIPS

American Society of Plant Biologists