Paulo Izquierdo, Ph.D.

Michigan State University

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EDUCATION

2022 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 Supervisors: 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:

15. **Izquierdo, P**., Kelly, J., Beebe, S. and Cichy, K. 2023. 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

14. 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. 2023. 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

13. Amongi, W., Nkalubo, S., Ochwo-ssemakula, M., Dramadri, I., Odongo, T., Nuwamanya, E., Tukamuhabwe, P., **Izquierdo, P**., Cichy, K., Kelly, J. and Mukankusi, C. 2023. 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

12. Sadohara, R., **Izquierdo, P**., Couto Alves, F., Porch, T., Beaver, J., Urrea, C. and Cichy, K. 2022. 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

11. Sadohara, R., Long, Y., **Izquierdo, P**., Urrea, C., Morris, D., and Cichy, K. 2022. 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

10. 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. 2020. 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

9. Berry, M., **Izquierdo, P**., Jeffery, H., Shaw, S., Nchimbi-Msolla, S., and Cichy, K. 2020. 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

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

7. **Izquierdo, P**., Shaw, S., Berry, M. and Cichy, K. 2017. 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.

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

5. Blair, M., **Izquierdo, P**., Astudillo, C., Grusak, M. 2013. 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

4. Delgado, H; Pinzón, E; Blair, M and **Izquierdo, P**. 2013. 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

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

2. Blair, M. W., & **Izquierdo, P**. 2012. 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

1. Blair, M; **Izquierdo, P**; Astudillo, C; Monserrate, F; Cortés, M., Avila, P., Felde, T., Pfieffer, W. 2011. 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.

Izquierdo, P; Sadohara, R; Wiesinger, J; Glahn, R; Urrea, C; Cichy, K. Genome-wide association and genomic prediction for Fe-Zn concentration and Fe bioavailability in a yellow bean collection of dry beans.

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:

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:

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

2022-2023 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).

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

Bean Improvement Cooperative
American Society of Agronomy
Crop Science Society of America
Soil Science Society of America