

 <p>First name: Ngonidzashe Last name: Chirinda Citizenship(s): Zimbabwe Date of Birth: 12 December 1977 Address: Mohammed VI Polytechnic University Lot 660, Hay Moulay Rachid Ben Guerir, 43150, Morocco E-mail: Ngonidzashe.Chirinda@um6p.ma Phone number: +212662448785</p>	<p>Scientific Articles: 65 Book Chapters: 6 Authored Book: 1 Conferences Presentations: 31 Total Citations: 3234 (Google scholar 27 February 2024) H-index: 27 HDR (Habilitation): 25 July 2023</p>
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Summary

I am an agroecologist with extensive experience in climate change mitigation research, policy implementation and mobilization of research funds. I investigate the effective application of science in attaining food security, farmer welfare and climate change mitigation goals. Over the past two decades, I have accumulated strategic leadership experience advising policymakers and funding organizations on environmental research priorities. To further enhance my knowledge and skills, I enrolled for a Global Online MBA with Warwick Business School in the UK.

1. GENERAL INFORMATION

1.1. Positions Held

April 2020 – to date	Assistant Professor in Sustainable Tropical Agriculture at Mohammed VI polytechnic university in Morocco.
Jan 2014- March 2020	Research Scientist and leader of the GHG Laboratory at the International Centre for Tropical Agriculture (CIAT-Colombia).
Jun. 2012–Jan. 2014	Coordinator of the Climate Food and Farming PhD student network within the CGIAR Research Program on Climate, Agriculture and Food Security.
Dec. 2010–Dec. 2013	Post-doctoral fellow at Aarhus University in Denmark, working on spatial and temporal carbon dynamics in cultivated landscapes.
May 2010–Dec. 2010	Research Assistant at Aarhus University in Denmark, working on root C inputs in organic and inorganic fertilizer-based cropping systems.

Feb. 2009–May 2009	Visiting Scholar at the Institute for Meteorology and Climate Research, Atmospheric Environmental Research in Germany, working on modelling GHG emissions from cropping systems using the biogeochemical model - MOBILE-DNDC.
Jun 2007–May 2010	PhD fellow at the University of Copenhagen in Denmark, working on understanding the influence of cropping systems on GHG emissions.
Aug. 2005–Jun. 2007	Lecturer at Great Zimbabwe University in the subject area of Rural Development, Faculty of Social Science. Supervising research projects for undergraduate students.
Jan. 2004–Jun. 2007	Part-time Tutor at the Zimbabwe Open University, Faculty of Agriculture. Supervising research projects for undergraduate students.
Aug. 2005–Jun. 2007	Lecturer at Great Zimbabwe University in the subject area of Rural Development, Faculty of Social Science.
Jan. 2004–Jun. 2007	Part-time Tutor at the Zimbabwe Open University, Faculty of Agriculture.
Jan. 2003–Aug. 2005	Ecologist in the Department of Natural Resources within the Ministry of Environment and Tourism in Zimbabwe.
Dec. 2000–May 2004	MPhil student at the University of Zimbabwe.

1.2. Other Positions and Affiliations

February 2023 – to date	Technical Working Group (TWG) of the Climate Bonds, Agri-food Criteria, focusing on [Crop and Livestock] sectors
January 2023 – to date	Climate Change Mitigation Panel Member for the Scientific and Technical Advisory Panel (STAP) of the Global Environment Facility (GEF).
November 2020 – to date	Coordinating Lead Author: Africa Integrated Assessment of Air Pollution and Climate Change Report
February 2019 – to date	Co-lead of the Global Research Alliance’s Inventories and Nationally Determined Contributions (NDC) Support Network
October 2018 – 2019	Member of the Agriculture Technical Working Group: Climate Bonds Initiatives

May 2018	Member of the Scientific Committee of the International Conference on Agricultural GHG Emissions and Food Security-Connecting research to policy and practice. <i>Chaired thematic working group 8: Knowledge and research gaps - Where do we need to develop transnational research?</i>
Feb 2017 - to date	Lead Author for chapters 2, 5, 6 and 11 of the 2019 Refinement to the IPCC's 2006 guidelines for national greenhouse gas inventory methodologies in Volume 4 (Agriculture, Forestry, and Other Land Use sector)

1.3. Education

2024-to date	Global MBA student Warwick Business School (United Kingdom).
2007-2010	PhD in Agriculture (Agroecology), University of Copenhagen (Denmark).
2000-2004	MPhil in Agriculture (Soil Science), University of Zimbabwe (Zimbabwe).
1997-2000	BSc in Agriculture (Soil Science), University of Zimbabwe (Zimbabwe).

2. EDITORIAL ACTIVITIES

Editorial Board member for the following journals:

- Nature Scientific Reports
- Frontiers in Sustainable Food Systems
- SOIL journal

3. AWARDS & HONORS

- Full Scholarship for my PhD studies
- Full Rockefeller Scholarship with full funding of my MPhil Studies
- Full Government Scholarship for my BSc studies
- EU COST-729; Grant (€5,000) for Short-term Scientific visit to the Institute for Meteorology and Climate Research, Atmospheric Environmental Research in Germany

4. PUBLICATIONS & PATENTS

4.1. Journal Articles

1. Madamombe, S.M., Karanja N.S., Öborn, I., Nyamadzawo, G., Chirinda, N., Kihara, J., Nkurunziza, L. (2024) Climate change awareness and adaptation strategies by smallholder farmers in semi-arid areas of Zimbabwe, *International Journal of Agricultural Sustainability*, 22:1, DOI: 10.1080/14735903.2023.2293588.

2. Loaiza, S., Verchot, L., Valencia, D., Guzmán, P., Amezcuita, N., Garcés, G., Puentes, O., Trujillo, C., **Chirinda, N.**, Pittelkow, C.M. (2024). Evaluating greenhouse gas mitigation through alternate wetting and drying irrigation in Colombian rice production. *Agriculture, Ecosystems and Environment*, 360, 108787.
3. Valencia Molina, M.C., Vera, J.C., Loaiza, S., Trujillo, C., Munera, B., Mauricio Castro Franco, M., Silva Parra, A., **Chirinda, N.**, Muñoz Arboleda, F. (2023). Carbon dioxide and nitrous oxide emissions from a typical sugarcane soil in the Cauca River Valley, Colombia. *Sugar Tech* <https://doi.org/10.1007/s12355-023-01328-2>.
4. Soremi, P.A.S., **Chirinda, N.**, Graterol, E., Alvarez, M. F. (2023) Potential of rice (*Oryza sativa* L.) cultivars to mitigate methane emissions from irrigated systems in Latin America and the Caribbean. *All Earth* 35(1): 2207941. ISSN: 2766-9645
5. **Chirinda, N.**, Metougui, M.L., El Gharous, M. (2023) Insights on Harnessing Domestic Biowaste for Greening the Green City of Benguerir in Morocco. *Sustainability*, 15, 2208. <https://doi.org/10.3390/su15032208>
6. Ruden, A.; Rivera, B.; Vargas, J.E.; López, S.; Gaviria, X.; **Chirinda, N.**; Arango, J. (2023). Evaluation of a Model (RUMINANT) for Prediction of DMI and CH₄ from Tropical Beef Cattle. *Animals*, 13, 721. <https://doi.org/10.3390/ani13040721>
7. Jaramillo-Botero, A., Colorado, J., Quimbaya, M., Rebolledo, M.C., Lorieux, M., Ghneim-Herrera, T., Arango, C.A., Tobon, L.E., Finke, J., Rocha, C., Muñoz, F., Riascos, J.J., Silva, F., **Chirinda, N.**, Caccamo, M., Vandepoele, K., Goddard, W.A., III (2022). The ÓMICAS alliance, an international research program on multi-omics for crop breeding optimization. *Front. Plant Sci.* 13:992663. [doi: 10.3389/fpls.2022.992663](https://doi.org/10.3389/fpls.2022.992663)
8. **Chirinda, N.**, Peters, M., Burkart, S., Notenbaert, A., Van Der Hoek, R. (2022) Editorial: Realizing livelihood and environmental benefits of forages in tropical crop-tree-livestock systems. *Front. Sustain. Food Syst.* 6:1056522. [doi: 10.3389/fsufs.2022.1056522](https://doi.org/10.3389/fsufs.2022.1056522)
9. Valencia-Salazar, S.S., Jiménez-Ferrer, G., Molina-Botero, I.C., Ku-Vera, J.C., **Chirinda, N.**, Arango, J. (2022). Methane mitigation potential of foliage of fodder trees mixed at two levels with a tropical grass. *Agronomy* 10.3390/agronomy12010100
10. Nkurunziza, L., Kuyah, S., Nyawira, S., Ng'ang'a, S.K., Musei, S., **Chirinda, N.**, Karugu, W., Smucker, A., Öborn, I. (2022). Reducing climate risks by improving food production and value chains: A case of sandy soils in semi-arid Kenya. *Frontiers in Climate* <https://doi.org/10.3389/fclim.2021.766583>.
11. Lombardi, B., Loaiza, S., Trujillo, C., Arevalo, A., Vázquez, E., Arango, J., **Chirinda, N.**, (2022). Greenhouse gas emissions from cattle dung depositions in two *Urochloa* forage fields with contrasting biological nitrification inhibition (BNI) capacity. *Geoderma*, 406, 115516
12. Notenbaert, A.M.O., Douxchamps, S., Villegas, D.M., Arango, J., Paul, B.K., Burkart, S., Rao, I., Kettle, C.J., Rudel, T., Vázquez, E., Teutscherova, N., **Chirinda, N.**, Groot, J.C.J., Wironen, M., Pulleman, M., Louhaichi, M., Hassan, S., Oberson, A., Nyawira, S.S., Pinares-Patino, C.S., Peters, M. (2021) Tapping Into the Environmental Co-benefits of Improved

- Tropical Forages for an Agroecological Transformation of Livestock Production Systems. *Front. Sustain. Food Syst.* 5:742842. doi: 10.3389/fsufs.2021.742842
13. Kuyah S., Sileshi, G.W., Nkurunziza, L., **Chirinda, N.**, Ndayisaba, P.C., Kangbéni Dimobe, K., Öborn, I. (2021). Innovative agronomic practices for sustainable intensification in sub-Saharan Africa. A review. *Agronomy for Sustainable Development* 41:16
 14. Andrieua, N., Hossard, L., Gravelined, N., Duguea, P., Guerraa, P., **Chirinda, N.** (2021). Covid-19 management by farmers and policymakers in Burkina Faso, Colombia and France: Lessons for climate action. *Agricultural Systems* 190, 103092
 15. González-Quintero, R., Bolívar-Vergara, D.M., **Chirinda, N.**, Arango, J., Pantevez, H., Barahona-Rosales, R., Sánchez-Pinzón, M.S. (2021). Environmental impact of primary beef production chain in Colombia: Carbon footprint, non-renewable energy and land use using Life Cycle Assessment. *Science of the Total Environment* 773, 145573.
 16. Durango Morales S.G., Barahona, R., Bovilar, D.M., Arango, J., Verchot, L., **Chirinda, N.** (2021). Apparent Nitrogen Recovery in Milk and Early Dry Season Nitrous Oxide Emission Factors for Urine Deposited by Dual-Purpose Cattle on Different Soil Types. *Frontiers in Sustainable Food Systems* DOI: 10.3389/fsufs.2020.602657
 17. Valencia-Salazar, S.S., Jime´nez-Ferrer, G., Arango, J., Molina-Botero, I., **Chirinda, N.**, Piñeiro-Vázquez, A., Jiménez-Ocampo, R., Nahed-Toral, J., Kú-Vera, J. (2021). Enteric methane mitigation and fermentation kinetics of forage species from Southern Mexico: in vitro screening. *Agroforestry Systems* <https://doi.org/10.1007/s10457-020-00585-4>
 18. **Chirinda, N.**, Trujillo, C., Loaiza, S., Salazar, S., Luna, J., Encinas, L.A.T., Becerra López Lavalle, L. A., Tran, T. (2021). Nitrous oxide emissions from cassava fields amended with organic and inorganic fertilizers. *Soil Use and Management* DOI: 10.1111/sum.12696.
 19. Anuga, S.W., Chirinda, N., Nukpezah, D., Ahenkan, A., Andrieu, N., Gordona, C. (2020) Towards low carbon agriculture: Systematic-narratives of climate-smart agriculture mitigation potential in Africa. *Current Research in Environmental Sustainability* 2, 100015.
 20. White, M., Heros, E., Graterol, E., **Chirinda, N.**, Pittelkow, C.M. (2020). Balancing Economic and Environmental Performance for Small-Scale Rice Farmers in Peru. *Front. Sustain. Food Syst.* <https://doi.org/10.3389/fsufs.2020.564418>.
 21. González-Quintero, R., Kristensen, T., Sánchez-Pinzón, M.S., Bolívar-Vergara, D.M., **Chirinda, N.**, Arango, J., Pantévez, H. A., Barahona-Rosales, R., Knudsen, M.T. (2020). Carbon footprint, non-renewable energy and land use of dual-purpose cattle systems in Colombia using a life cycle assessment approach. *Livestock Science* <https://doi.org/10.1016/j.livsci.2020.104330>.
 22. Sylvester, J., Valencia Gomez, J., Verchot, L.V., **Chirinda, N.**, Romero Sanchez, M., A., Quintero, M., Castro-Nuñez, A, 2020. A rapid approach for informing the prioritization of degraded agricultural lands for ecological recovery: A case study for Colombia. *Journal for Nature Conservation* 58, 125921.
 23. Gaviria-Uribe, X., Bolivar, D., Rosenstock, T., Molina-Botero, C.I., **Chirinda, N.**, Barahona, R., Arango, J. (2020). Nutritional quality, voluntary intake and enteric methane

- emissions of diets based on novel Cayman grass and its associations with two *Leucaena* shrub legumes. *Frontiers in Veterinary Science* <https://doi.org/10.3389/fvets.2020.579189>
24. González-Quintero, R., Barahona-Rosales, R., Bolívar-Vergara, D.M., **Chirinda, N.**, Arango, J., Pantévez, H. A., Correa-Londoño, G., Sánchez-Pinzón, M.S. (2020) Technical and environmental characterization of dual-purpose cattle farms and ways of improving production: A case study in Colombia. *Pastoralism* 10, 19 <https://doi.org/10.1186/s13570-020-00170-5>
 25. Ku-Vera, J. C., Castelán-Ortega, O. A., Galindo-Maldonado, F. A., Arango, J., **Chirinda, N.**, Jiménez-Ocampo, R., Valencia-Salazar S. S., Flores-Santiago, E. J., Montoya-Flores, M. D., Molina-Botero, I. C., Piñeiro-Vázquez A. T., Arceo-Castillo J. I., Aguilar-Pérez C. F., Ramírez-Avilés L., and Solorio-Sánchez F. J. (2020). Review: Strategies for enteric methane mitigation in cattle fed tropical forages. *Animal*, 1-11. doi:10.1017/S1751731120001780
 26. Molina Botero C. I., Mazabel, J., Arceo-Castillo, J., Luis Urrea-Benítez, J., Olivera-Castillo, L., Barahona B.R., **Chirinda, N.**, Ku-Vera, J.C., Arango, J. (2020). Effect of the addition of *Enterolobium cyclocarpum* pods and *Gliricidia sepium* forage to *Brachiaria brizantha* on dry matter degradation, volatile fatty acid concentration, and in vitro methane production. *Tropical Animal Health and Production* <https://doi.org/10.1007/s11250-020-02324-4>.
 27. Arango, J., Ruden, A., Martinez-Baron, D., Loboguerrero, A.M., Berndt, A., Chacón, M., Torres, C. F., Oyhantcabal, W., Gomez, C.A., Ricci, P., Ku-Vera, J., Burkart, S., Jon M. Moorby, J.M., **Chirinda, N.** (2020). Ambition Meets Reality: Achieving GHG Emission Reduction Targets in the Livestock Sector of Latin America. *Frontiers In Sustainable Food Systems* 4:65.
 28. Smith, P., Soussana, J-F., Angers, D., Schipper, L., Chenu, C., Rasse, D.P., Batjes, N. H., van Egmond, F., McNeill, S., Kuhnert, M., Arias-Navarro, C., Olesen, J.E., **Chirinda, N.**, Fornara, D., Wollenberg, E., Álvaro-Fuentes, J., Sanz-Cobena, A., Klumpp, K. (2019). How to measure, report and verify soil carbon change to realise the potential of soil carbon sequestration for atmospheric greenhouse gas removal. *Global Change Biology* DOI: 10.1111/gcb.14815.
 29. González-Quintero, R., Sánchez-Pinzón, M. S., Bolívar-Vergara, D. M., **Chirinda, N.**, Arango, J., Pantévez, H. A., Correa-Londoño, G., Barahona-Rosales, R. (2019). Technical and environmental characterization of Colombian beef cattle-fattening farms, with a focus on farm size and ways of improving production. *Outlook on Agriculture*, 1-10 p.
 30. Nkurunziza, L., **Chirinda, N.**, Lana, M., Sommer, R., Karanja, S., Rao, I., Sanchez, M.R., Quintero, M., Kuyah, S., Lewu, F., Joel, A., Nyamadzawo, G., Smucker, A. (2019). The Potential Benefits and Trade-Offs of Using Sub-surface Water Retention Technology on Coarse-Textured Soils: Impacts of Water and Nutrient Saving on Maize Production and Soil Carbon Sequestration. *Frontiers In Sustainable Food Systems* <https://doi.org/10.3389/fsufs.2019.00071>.
 31. Guzman, C.D., Villada, F.H., Da Silva, M., Zimale, F.A., **Chirinda, N.**, Botero, C., Morales, A., River, B., Moreno, B., Steenhuis, T.S. (2019). Variability of soil surface

- characteristics in a mountainous watershed in Valle del Cauca, Colombia: Implications for runoff erosion and conservation. *Journal of Hydrology* 576, 273-286.
32. Osorio-García, A.M., Paz, L., Howland, F., Ortega, L.A., Acosta-Alba, I., Arenas L., **Chirinda N.**, Martinez-Baron, D., Bonilla Findji, O., Loboguerrero, A.M., Chia, E., Andrieu, N. (2019). Can an innovation platform support a local process of Climate-Smart Agriculture implementation? A case study in Cauca, Colombia. *Agroecology and Sustainable Food Systems* DOI: <https://doi.org/10.1080/21683565.2019.1629373>.
 33. **Chirinda N.**, Loaiza, S., Arenas, L., Ruiz, V., Faverín, C., Alvarez C., Savian, J.V., Belfon R., Zuniga K., Morales, L., Trujillo, C., Arango, M., Rao, I., Arango, J., Peters, M., Rolando Barahona, R., Costa Junior C., Todd S. Rosenstock, T.S., Richards, M., Martinez-Baron D., Cardenas, L. (2019). Adequate vegetative cover decreases nitrous oxide emissions from cattle urine deposited in grazed pastures under rainy season conditions. *Nature Scientific Reports* 9, 908 <https://doi.org/10.1038/s41598-018-37453-2>
 34. Wassmann, R., Sander, B.O., Sudhir, Y., Bouman, B., Singleton, G., Stuart, A., Hellin, J., Johnson, D., Hughes, J., Butterbach-Bahl, K., Kiese, R., Kraus, D., Janz, B., Linquist, B., Gaihre, Y.K., **Chirinda, N.**, Wollenberg, E. (2019). New records of very high nitrous oxide fluxes from rice cannot be generalized for water management and climate impacts *Proceedings of the National Academy of Sciences of the United States of America*. 116, 1464–1465.
 35. Cordoba, E., **Chirinda, N.**, Li, F., Olesen, J.E. (2018). Contributions from carbon and nitrogen in roots to closing the yield gap between conventional and organic cropping systems. *Soil Use and Management* doi: 10.1111/sum.12427.
 36. **Chirinda, N.**, Arenas, L., Katto, M.,.....Bayer, C. (2018). Sustainable and Low Greenhouse Gas Emitting Rice Production in Latin America and the Caribbean: A Review on the Transition from Ideality to Reality. *Sustainability*. 671. doi:10.3390/su10030671
 37. Nuñez, J., Arevalo, A., Karwat, H., Egenolf, K., Miles, J., **Chirinda, N.**, Cadisch, G., Rasche, F., Rao, I., Subbarao, G., Arango, J. (2018). Biological nitrification inhibition activity in a soil-grown biparental population of the forage grass, *Brachiaria humidicola*. *Plant and Soil*. <https://doi.org/10.1007/s11104-018-3626-5>.
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60. **Chirinda, N.**, Olesen, J.E., Porter J.R. (2012). Root carbon input in organic and inorganic fertilizer-based systems. *Plant and Soil* 359, 321–333.
61. **Chirinda, N.**, Kracher, D. Lægdsmand, M., Porter, J.R., Olesen, J.E., Petersen, B. M., Doltra, J., Kiese, R., Butterbach-Bahl, K. (2011). Simulating soil N₂O and CO₂ emissions

- from arable cropping systems using FASSET and MOBILE-DNDC. *Plant and Soil* 343, 139–160.
62. **Chirinda, N.**, Olesen, J.E., Porter J.R. (2011). Post cold storage conditioning time affects soil denitrifying enzyme activity. *Communications in Soil Science and Plant Analysis* 42, 2160–2167.
 63. **Chirinda, N.**, Carter, M.S., Albert, K.R, Ambus, P., Olesen, J.E., Porter, J.R., Petersen, S.O. (2010). Emissions of nitrous oxide from arable organic and conventional cropping systems on two soil types. *Agriculture, Ecosystems and Environment* 136, 199–208.
 64. **Chirinda, N.**, Olesen, J.E., Porter, J.R. Schjøning, P. (2010). Soil properties, crop production and greenhouse gas emissions from organic and inorganic fertilizer-based arable cropping systems. *Agriculture, Ecosystems and Environment* 139, 584–594.
 65. Porter, J.R., **Chirinda, N.**, Felby, C., Olesen, J.E. (2008). Biofuels: Putting current practices in perspective. *Science* 320, 1421.

4.2. Peer-Reviewed Conference Proceedings

1. Gonzalez, R., Sánchez-Pinzón, M.S., Bolívar-Vergara, D.M., **Chirinda, N.**, Arango, J., Barahona, R. (2018). Carbon Footprint (CF) in Breeding Cattle Systems in Colombia. In: Tropentag 2018: “Global food security and food safety: The role of universities” September 17-18, 2018, Ghent. 1p.
2. Loaiza S., Loboguerrero, A.M., Martínez-Baròn, D., Da Silva, M., Paz, L., Luis Ortega, L., **Chirinda, N.** (2018). Shaded coffee: An adaptation strategy mitigating short-term fertilizer-based soil N₂O emissions from hilly landscapes. International Conference on Agricultural GHG Emissions and Food Security – Connecting research to policy and practice September 10 – 13, 2018, Berlin, Germany.
3. Ruden, A., Serna, L., Gaviria, X., Sotelo, M., Trujillo, C., Mazabel, L.J., Stiven Quintero, S., Tapasco, J., **Chirinda, N.**, Arango, J. (2018). Validation of the Ruminant model to obtain accurate estimates of enteric methane emissions to support the Colombian NDCs. International Conference on Agricultural GHG Emissions and Food Security – Connecting research to policy and practice September 10 – 13, 2018, Berlin, Germany.
4. Rivera-Zayas, J., Arevalo, A., Trujillo, C., Loaiza, S., **Chirinda, N.**, Arango, J., Rice C.W. (2017). Characterization of N Dynamics and Soil Microbial Communities as a Result of Biological Nitrification Inhibition by Brachiaria Grasses. Presented at the Managing Global Resources for a Secure Future Annual Meeting, Tampa, Florida, USA, October 2017.
5. Arango, J., Fisher, M., Castro, A., Cardoso, J.A., Hyman, G., **Chirinda, N.**, Da Silva, M., Lascano, C., Miles, J., Peters, M., Tohme, J., Rao, I. (2017). Forage cultivation influence in soil carbon accumulation. Presentation at CIAT Tropical Forages Program and Livestock CRRP at COP 23, Bonn, Germany, 12 November 2017.
6. Arenas L., Andrieu N., Osorio, A.M., Martinez, D., Loboguerrero, A.M., Liliana, P., Ortega, L., Loaiza, S., **Chirinda, N.** (2017). Does Organic Fertilisation in the Colombian

- Climate-Smart Village Support the Transition Towards Climate Smartness? Future Agriculture: Social-ecological transitions and bio-cultural shifts September 20 - 22, 2017, University of Bonn and the Center for Development Research, Bonn, Germany
7. **Chirinda, N.**, Arenas, L., Katto, M.,.....Bayer, C. (2017). The past, present and future of climate change mitigation research for irrigated rice systems in Latin America and the Caribbean (LAC). JIRCAS-NARO International Symposium on Agricultural Greenhouse Gas Mitigation. August 29-30.
 8. **Chirinda, N.**, Arenas, L., Loaiza, S.,...Barahona, R. (2017). Novel technological and management options for accelerating transformational changes in rice and livestock systems. The 23rd International Sustainable Development Research Society Conference, Bogota, Colombia, 14-16 June.
 9. González Quintero, R., Sanchez Pinzón, M.S., Bolívar Vergara, D.M., **Chirinda, N.**, Zuluaga, A.F., Barahona Rosales R. (2017). Uso del suelo en sistemas de cría y ceba bovina de diferente tamaño en 13 departamentos en Colombia. Poster <https://cgspace.cgiar.org/handle/10568/89102>
 10. Carolina, A., Arango, J., **Chirinda N.**, Mazabel J., Rao I., Barahona R., Peters M., Rosenstock, T., Becerra L, A. (2016). Cassava leaves reduce the quantity of methane produced through enteric fermentation. International Conference Steps to Sustainable Livestock, 12 – 15th January 2016, University of Bristol, UK.
 11. Arango, J., Chacón, M., Segura, J., Chacón, A., Villanueva, C., Rosenstock, T., Ordoñez, J., Abarca, S., Vivas, N., Barahona, R., Bolivar, D., Plazas, C., Tapasco, J., Escobar, D., **Chirinda, N.**, Laderach, P., Rao, I.M. (2016). GANADERÍAPLUS: Apoyando el desarrollo de estrategias bajas en emisiones del sector ganadero de Latinoamérica [Resumen]. In: LXI PCCMCA: Reunión Anual del Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos y Animales (5-8, Abril, 2016, Costa Rica). Costa Rica. P 94
 12. Notenbaert, A., Cardoso, J. A., **Chirinda, N.**, Peters, M., Mottet, A. (2016). Climate change impacts on livestock and implications for adaptation: Climate impacts on land use, food production and productivity session. International Center for Tropical Agriculture (CIAT). Rome, IT. 30 p, <https://hdl.handle.net/10568/79461>.
 13. Arango, J., Moreta, D., Nuñez, J., Arevalo.... **Chirinda, N.**, Hyman, G., Rao, I. (2016). Climate-Smart Crop-Livestock Systems for Smallholders in the Tropics: Regulation of Nitrification in Soil by *Brachiaria humidicola* Hybrids [abstract]. In: Tropentag 2016: Solidarity in a competing world — fair use of resources (18-21, September 2016, Vienna, Austria). Vienna, Austria. 2 p.
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16. **Chirinda, N.**, Arenas, L., Milton, V.O, Loaiza, S.P., Chaparro, P.A., Trujillo, C., Ishitani, M., Asante, M., Dartey, K., Lamo, J., Addae, P., Sanni, K., Selvaraj, M. (2015). Transgenic technology: A strategic tool for reducing N₂O emissions from rice ecosystems. XII International Rice Conference for Latin America and the Caribbean, 23rd – 26th February Porto Alegre, RS, Brazil.
17. **Chirinda, N.**, Heve, W.K. Adiku, S.G., Olesen, J.E. (2013). Harmonizing stakeholder efforts for climate change adaptation in Northern Ghana. First International Conference on Global Food Security 29 Sept -2 October, Noordwijkerhout, The Netherlands.
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25. **Chirinda, N.**, Kracher, D. Lægdsmand, M., Porter, J.R., Olesen, J.E., Kiese, R., Butterbach-Bahl, K. (2009). Simulating soil N₂O and CO₂ emissions from arable organic and conventional systems using MOBILE-DNDC. Managing Climate Change MC² Conference 18–20 November 2009, Massey University, Palmerston North, New Zealand.
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28. **Chirinda, N.**, Olesen, J.E., Porter, J.R. (2008). Effects of organic matter input on soil microbial properties and crop yields in conventional and organic cropping systems. In: Proceedings of the 2nd scientific conference of the International Society of Organic Agriculture Research held at the 16th IFOAM Organic World Congress. Modena, Italy.
29. **Chirinda, N.**, Muusha, M., Manyange, E., Mbetu J. (2007). Contribution of palustrine wetlands on livelihoods in semi-arid Masvingo District of Zimbabwe. SADC Land and Water Management, 2nd scientific symposium in Botswana.
30. Pambirei, N., **Chirinda, N.**, Sibanda, M. (2007). The paradox of crop selection in semi-arid Chivi district, Zimbabwe. SADC Land and Water Management, 2nd scientific symposium in Botswana.
31. **Chirinda, N.**, Muusha, M., Manyange, E., Mbetu J. (2005). Introduction of Soil and Water Conservation Techniques at Shashe Block of Farms in Masvingo District. In: Proceedings of the World Congress on Conservation Agriculture, Nairobi, Kenya.

4.3. Reviews, Book Chapters, Editorials, Books

Lead author of the following chapters in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories:

1. Chapter 2: Generic methodologies applicable to multiple land-use categories
2. Chapter 5: Cropland
3. Chapter 6: Grassland
4. Chapter 11: N₂O emissions from managed soils, and CO₂ emissions from lime and urea application
5. **Chirinda, N.**, Mpeperekhi, S., Giller, K.E., Zengeni, R. (2002). Soyabean yield response to different rhizobial inoculation rates on selected sandy soils in Zimbabwe: In: Grain legumes

- and green manures for soil fertility in Southern Africa: Taking stock of progress. (eds) S.R. Waddington. ISBN 9706481133. pp: 47 -52.
6. Rosenstock, T.S., Rufino, M.C., **Chirinda, N.**, van Bussel, L., Reidsma, P., Klaus Butterbach-Bahl, K. (2016). Scaling point/plot measurements of greenhouse gas fluxes, balances and intensities to whole-farms and landscapes. *Methods for Measuring Greenhouse Gas Balances and Evaluating Mitigation Options in Smallholder Agriculture* pp 175-188.

Co-authored the following info notes, reports, working papers and policy briefs

1. Ruden, A., Serna, L., Gaviria, X., Sotelo, M., Gutiérrez, J.F., Trujillo, C., Mazabel, J., Quintero, S., Villegas, D., Tapasco, J., Richards, M., **Chirinda, N.**, Arango, J. (2018). Model of enteric methane emissions supports climate change mitigation in Colombia's cattle sector. CCAFS Info Note. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). <https://hdl.handle.net/10568/97097>
2. Arora, D., Arango, J., Burkart, S., **Chirinda, N.**, Twyman, J. (2017). Gender [im]balance in productive and reproductive labor among livestock producers in Colombia: Implications for climate change responses. CCAFS Info Note. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). <https://hdl.handle.net/10568/79940>
3. Marin, A., Baldissera, T., Pinto, C., Garagorry, F., Zubieta, A., Giraldo, L., **Chirinda, N.**, Arango, J., Carvalho, P. (2017). Una innovación en el manejo del pastoreo como estrategia para mejorar la producción animal y reducir las emisiones de GEI. CCAFS Info Note. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). <https://hdl.handle.net/10568/89804>
4. Marin, A., Baldissera, T., Pinto, C., Garagorry, F., Zubieta, A., Giraldo, L., **Chirinda, N.**, Arango, J., Carvalho, P. (2017). Grazing management innovation as a strategy to improve animal production and reduce GHG emissions. CCAFS Info Note. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). <https://hdl.handle.net/10568/89803>
5. Durango, S., Gaviria, X., Gonzalez, R., Sotelo, M., Gutierrez, J., **Chirinda, N.**, Arango, J., Barahona, R. (2017). Iniciativas de mitigación al cambio climático en sistemas de producción de carne bovina en países tropicales. CCAFS Info Note. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). <https://hdl.handle.net/10568/79950>
6. Durango, S., Gaviria, X., González, R., Sotelo, M., Gutiérrez, J., **Chirinda, N.**, Arango, J., Barahona, R. (2017). Climate change mitigation initiatives in beef production systems in tropical countries. CCAFS Info Note. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). <https://hdl.handle.net/10568/81302>
7. Serna, L., Escobar, D., Tapasco, J., Arango, J., **Chirinda, N.**, Chacon, M., Segura, J., Villanueva, C. (2017). Challenges and Opportunities for the Development of the Livestock

- NAMA in Colombia and Costa Rica. CCAFS Info Note. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
<https://hdl.handle.net/10568/81300>
8. Serna, L., Escobar, D., Tapasco, J., Arango, J., **Chirinda, N.**, Chacon, M., Segura, J., Villanueva, C. (2017). Retos y oportunidades para el desarrollo de la NAMA Ganadería en Colombia y Costa Rica. CCAFS Info Note. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
<https://hdl.handle.net/10568/79953>
 9. Serna, L., Ruden, A., Gaviria, X., Sotelo, M., Gutiérrez, J.F., Trujillo, C., Mazabel, J., Quintero, S., Tapasco, J., Barahona, R., **Chirinda, N.**, Arango, J. (2017). Validación del modelo RUMINANT para obtener estimaciones precisas de las emisiones de metano entérico en condiciones tropicales para apoyar las Contribución Prevista Determinada a Nivel Nacional (NDC) Colombianas. <https://www.slideshare.net/secret/LA3C28LWO7whD6>
 10. García, M.A., Twyman, J., Katto, M.C., **Chirinda, N.** (2016). Reconociendo a las mujeres del arroz en Colombia: Un paso para las tecnologías de mitigación al cambio climático. Resultados de un estudio socioeconómico con perspectiva de género. Infonota Género. Centro Internacional de Agricultura Tropical (CIAT). Cali, Colombia. 6 p.
<https://hdl.handle.net/10568/79975>
 11. García, M.A., Katto, M.C., Twyman, J., LaHue, G., **Chirinda, N.** (2016). How might gender roles affect the implementation of a new water-saving technique for Colombian rice production? Report of gender dimensions in Colombian rice production. Working Paper. CIAT Publication No. 437. International Center for Tropical Agriculture (CIAT), Cali, Colombia. 37 p. <https://hdl.handle.net/10568/81594>
 12. Quintero, M., Sachet, E., Wyckhuys, K., Cordingley, J., Kizito, F., Cruz-García, G.S., Winowiecki, L., Rajasekharan, M., Valbuena, D., **Chirinda, N.** (2015). Ecosystem Action – CIAT’s Ecosystem Services Strategic Initiative. Cali, CO: Centro Internacional de Agricultura Tropical (CIAT). 30 p. <https://hdl.handle.net/10568/68471>
 13. Rao, I., Peters, M., Castro, A., ...**Chirinda, N.**, Rudel, T. (2015). LivestockPlus – The sustainable intensification of forage-based agricultural systems to improve livelihoods and ecosystem services in the tropics. Cali, CO: Centro Internacional de Agricultura Tropical (CIAT), 40 p. (CIAT Publication No. 407). <https://hdl.handle.net/10568/68840>

Co-authored the following newsletters and newsletter articles:

1. Sanz-Cobena, A., Pickering, A., Baranski, M., **Chirinda N.**, Eckard, R. (2019) Inventories and NDC Network Newsletter No.1 April 2019
2. Carter, M.S., **Chirinda, N.** (2009). No effect of cropping system on the greenhouse gas N₂O. ICROFS News, no. 2, pp. 9-10.
3. **Chirinda, N.**, Olesen, J.E., Porter J.R. (2012). Root carbon input in arable systems: A largely untold story. ICROFS News, no. 2, pp. 10-11.

4.4. Ph.D. Theses

Title of thesis: Influence of cropping systems on greenhouse gas emissions

4.5. M.Sc. Theses

Title of thesis: Optimizing selected agronomic practices to enhance yields in maize and soyabean rotation systems under smallholder cropping conditions.

5. CONTRIBUTED PAPERS (NATIONAL AND INTERNATIONAL CONFERENCES)

6. FUNDING

Funded projects and short-term scientific missions

Funding Agency	Project Acronym/short name	Budget		Role	Consortium
		Total	Share		
OCP Fondation	Carbon Flagship Programme	USD 12,000,000	N/A	Principal Investigator	TBD
Phosboucraa fondation	DAREF	1,888,000 MAD	100,000 MAD	Investigator	ASARI, AITTC
Belmont Forum	WESAFOO	€968,000	€93,000	Investigator	IWRI, AITTC
PRIMA	SPORE-MED	€4,000,000	€268,000	Investigator	UdG, INIMA, University of Sfax, Univ. Salerno, TUC, ADASA, Univ. of Cyprus
USAID	agrivoltaics workshop	USD20,000	USD 100,000	Principal Investigator	Galilee Research Institute; Abu Dhabi University; Al-Azhar University; National Agriculture Research Center-Jordan; UM6P
OCP-Foundation	Africa Carbon programme	USD 1,000,000	USD 100,000	Principal Investigator	APNI, ACPCU, Farmers Direct
UM6P	Agrivoltaics Platform and Greenhouse gas laboratory	USD 500,000	USD 500,000	Principal Investigator	UM6P, Green Energy Park

Curriculum Vitae template UM6P

OCP-Sustainability	MRV project	USD500,000	USD134,000	Principal Investigator	UM6P, OCP, REGROW
Global Research Alliance	MedCiFoS	€25,000	€10,000	Principal Investigator	UM6P, Universidad politécnica de Madrid, Wageningen University, INRAT – Tunisia
ENSUS	Enviro-septic	500,000 MAD	500,000 MAD	Principal Investigator	UM6P (AITTC, ASARI, IWRI) and Beyond Engineering
European Union	RUSTICA	€8,636,608	€179,214	Investigator	RUSTICA Consortium of 16 institutions
Nordic Climate Facility	SWRT-Kenya	€449,175	€57,960	Co-Principal Investigator	CIAT, SLU, Michigan State University SWRT Solutions, JKUST
BBSRC-UK	CoForLife	£663,462	£100,000	Co-Principal Investigator	Aberystwyth University, CIAT, University of Glasgow, University of Antioquia
Swedish Research Council	SWRT-Zimbabwe	5,794,541 SEK	1,744,381 SEK	Co-Principal Investigator	CIAT, SLU, Michigan State University SWRT Solutions, Bindura University
CAAFS CGIAR Research Programme	LivestockPlus (Phase II)	USD900,000	USD450,000	Co-Principal Investigator	CIAT, UNAL-Medellin
International Joint Research Program, University of Illinois	Sustainable Rice Production Latin America	USD20,000	USD6,000	Co-Principal Investigator	University of Illinois, CIAT
Colciencia - Colombia	OMICAS	USD5,507,910	USD120,000	Co-Principal Investigator	OMICAS consortium of members 17 institutions
IKI, Germany, GGGI	Biogas	€455,000	€55,000	Principal Investigator	CIAT, GICON, GGGI

USDA	EC-LEDS Colombia Cacao & GHG Inventories	USD200,000	USD100,000	Co-Principal Investigator	CIAT, Fedecacao, Climate solutions
CIRAD	GHG emissions in Cassava	USD20,000	USD 10,000	Co-Principal Investigator	CIAT, CIRAD
FONTAGRO	More rice with less emissions and lower water consumption	USD300,000	USD20,000	Co-Principal Investigator	Fedearroz, CIAT, La Molina Agrarian University, Agricultural Research Institute (INIA)-Chile
UK Space Agency	EcoProMIS	£3,915,644	£250,000	Co-Principal Investigator	Agricompas, CIAT, Fedearroz, Solidaridad, Pixalytics
IKI-BMU Germany	SLUS	€5,200,000	€100,000	Investigator	CIAT, CIPAV, Leibniz Centre for Agricultural Landscape Research, and Thünen-Institut.
BBSRC, UK	Advancing sustainable forage-based livestock production	£109,000	£10,000	Co-Principal Investigator	CIAT, University of Glasgow
BBSRC, UK	Climate-smart forage-based diets	£100,772	£20,000	Co-Principal Investigator	CIAT, Aberystwyth University
The World Bank	BioCarbon Fund Orinoquia – scoping study	USD 200,000	USD 10,000	Investigator	Different government departments in Colombia
USAID	Validation of RUMINANT model to support Colombian INDCs	USD 200,000	USD100,000	Co-Principal Investigator	CIAT, UNAL- Medellin
CCAFS CGIAR Research Programme	LivestockPlus (Phase I)	USD3,760,000	USD210,000	Co-Principal Investigator	CIAT, ICRAF, CATIE
Livestock and Fish CGIAR Research Programme	GASMET system	USD100,000	USD50,000	Co-Principal Investigator	CIAT

Clean Climate and Air Coalition	Mitigation of Methane Emissions from Flooded Rice Fields in Colombia	USD343,200	USD343,200	Principal Investigator	CIAT, Fedearroz
DANIDA	Technological and market options for managing climate change-induced risks for smallholder farmers in Northern Ghana	5,023,329 DKK	180,000DKK	Investigator	Aarhus University, Technical University of Denmark, Denmark University of Copenhagen, Institute of Economics Affairs- Ghana
Aarhus University	Bridge Post-doc: Crop root C inputs	USD 36,000	USD36,000	Principal Investigator	Aarhus University

8. SERVICE

8.1. Expert Panels, Committees, Boards (in chronological order)

- Panel member, Expert panel on livestock methane, **2023 to date**.
- Panel member, Scientific and Technical Advisory Panel of the Global Environment Facility (GEF), **2022 to date**.

8.2. Conferences (in chronological order)

- Co-Chair The 9th International Symposium on Soil Organic Matter, **26-31 May 2024**

8.4. Faculty Level

- Committee member/ College Research Committee, **2023- to date**.
- Committee member/College Seminar organization Committee, **2023- to date**.

8.5. Peer Review

- Plant and Science
- Global Change Biology
- Frontiers in Sustainable Food Systems
- NJAS: Impact in Agricultural and Life Sciences
- Philosophical Transactions B
- Geoderma

9. TEACHING ACTIVITIES

Semester & Year	Course #, Credit Hours & Type	Title of Course	Number of Students	Students' Classification
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				(undergrad or graduate)
Semester 1, year 1	Masters in Agribusiness innovation: Sustainable Water, Soil and Forest Management, 8 hours	Soil Management	19	Graduate
Semester 1, year 1	Carbon Cycling and Climate Change (MSc)	Soil N ₂ O measurements	15	Graduate
Semester 1, year 1	Agriculture in a Global Context (BSc)	(1) Global crop production and (2) Agricultural production in Africa.	20	Undergraduate
Semester 1,2,3 and 4, year 1 and 2	Rural Development	(1) Land Resource Conservation; (2) Rural Energy Technologies (3) Water Resource Management (4) Rural Resettlement and Agrarian Reform (5) Migration and Development	80	Undergraduate
Semester 1,2,3 and 4, year 1 and 2	Agricultural Science	Introduction to Soil Science, (2) Applied Soil Science, (3) Introduction to Horticulture, (4) Natural Resource Conservation and Management, (5) Ecology and Wildlife Management	50	Undergraduate (Distant learning)

10. HIGHLY QUALIFIED PERSONNEL (HQP)

List of current and past group members (add/remove line as needed)

	Name	Project/Thesis Title	Period	Current Position
	Ph.D. Students			
1.	Sandra Durango	Efecto de diferentes asociados forrajeros sobre la excrecion de nitrogeno en ganado bovino y su contribucion a las emisiones de oxido nitroso y metano provenientes de parches de orina y estiércol en el tropico colombiano	2016 - 2021	(Graduated) Postdoc fellow in the CGIAR
2.	Ricardo González-Quintero	Use of Life Cycle Assessment (LCA) methodology to estimate the environmental impacts and the feasibility of scaling up low carbon emission practices in cattle systems in Colombia	2016 - 2020	(Graduated) Postdoc fellow in the CGIAR
3.	Xiomara Gaviria	Emisiones de metano y su relacion con la calidad nutricional y el consumo voluntario de	2016 - 2021	(Graduated) Postdoc fellow at the National University of Colombia

		dietas basadas en forrajes tropicales		
4.	Mohamed Boullouz	Quantifying greenhouse gas emissions from fertilizer-based crop production systems	2022 -	On-going
5.	Nabil EL KHATRI	Quantifying carbon sequestration at rehabilitated old mining sites in Morocco	2022 -	On-going
6.	FatimaEzzahra JABBOUR	Tillage and fertilizer effects on soil quality, carbon dynamics and N ₂ O emissions in cereal fields	2022 -	On-going
7.	Kassim, Yussif Baba	Effects of fertilization on productivity and nutritional quality of crops in Northern Ghana	2019 -	On-going
8.	Aziza TANGI	Improving opportunities for women in smallholder olive value chains in Morocco	2022 -	On-going
9.	Sandra Makaita Madamombe	Climate smart agriculture options for improved livelihoods and sustainable agriculture on coarse textured soils in semi-arid areas of Zimbabwe	2018 -	On-going
10.	Intissare MOUAMINE	Carbon Dynamic and Soil Health Attributes Profiling in Moroccan Olive Systems	2023-	On-going
11.	IMANE HROUR	Soil quality, carbon dynamics and N ₂ O emissions from cereal-legume cropping systems	2022 -	On-going
	M.Sc. Students			
12.	Laura Arenas	Diseño de cámara estática cerrada y medición de flujos de gases de efecto invernadero (GEI) en suelos	2015-2016	(Graduated) Now Postdoc Associate with Cornell University
	Visiting Scholars, Scientists, Students			
13.	Svenja Doreen Roncossek (MSc)	Soil carbon dynamics in arable landscapes	2011-2013	Unknown
14.	William K. Heve (PhD)	Targeted management of organic resources for sustainably increasing soil organic carbon: Observations and perspectives for resource use and climate adaptations in northern Ghana	2011-2012	Lecturer University of University of Environment and Sustainable Development
15.	Banira Lombardi (PhD)	Greenhouse gas emissions from cattle dung depositions in two Urochloa forage fields with contrasting biological nitrification inhibition (BNI) capacity	2018	Postdoc fellow AgResearch New Zealand
16.	Paul Soremi (PhD)	Potential of rice (<i>Oryza sativa</i> L.) cultivars to mitigate methane emissions from irrigated systems in Latin America and the Caribbean	2019	Lecturer at Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
17.	Samuel W. Anuga	Just how smart are the climate smart villages?	2018	Research Associate at Global Research Alliance
18.	Abubakar Halilu Girei	Evaluating greenhouse gas mitigation through alternate	2018	Unknown

		wetting and drying irrigation in Colombian rice production		
	Technical staff (permanent)			
19.	Catalina Trujillo	Greenhouse gas laboratory coordinator	2016-2020	MSc graduate at ICESI University Cali Colombia
20.	Sandra Loaiza	Greenhouse gas field measurements coordinator	2014-2020	PhD student at Javeriana Cali Colombia

11. COLLABORATORS (current and past, in chronological order)

11.1. Academia

- Libère Nkurunziza (Associate Professor), Department of Crop Production Ecology, Swedish University of Agricultural Sciences (SLU), Sweden.
- Lars Elsgaard (Full Professor), Department of Agroecology - Soil Fertility at Aarhus University, Denmark
- Job Maguta Kihara, (Senior Scientist), Alliance Bioversity-CIAT, Kenya

11.2. Industry

- Dr William Salas (Chief strategist), Regrow, USA.
- Alvin Smucker (Founder and President), SWRT Solutions, LLC, USA
- Ahmed El Maaloum (Founder CEO), Beyond Engineering, Water and Environment Engineer, Morocco
- Chrys Pablo, (Agri-Food Program Coordinator), Climate Bonds Initiative, Belgium.

11.3. Governments

- In my role at the Scientific and Technical Advisory Panel of the GEF, I advise on project submitted by governments from GEF-funding recipient countries (<https://www.thegef.org/projects-operations/recipient-countries>).
- As co-lead of the Global Research Alliance's Inventories and Nationally Determined Contributions (NDC) Support Network, I provide support to GRA member states (<https://globalresearchalliance.org/updates-tags-key/member-countries/>) on their Greenhouse gas inventories.
- I was coordinating lead author of a document that was commissioned by the African Union to inform Greenhouse gas and pollution mitigation actions across Africa (<https://www.ccacoalition.org/resources/full-report-integrated-assessment-air-pollution-and-climate-change-sustainable-development-africa>).
- I was lead author for the IPCC and the guidelines I co-authored will be used to inform greenhouse gas inventories by all the countries in the world (<https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/>).