CURRICULUM VITAE OF AGUSTIN DEL PRADO

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ANNEX 21

ONE-PAGE *CURRICULUM VITAE* OF AGUSTIN DEL PRADO

Academic:

- PhD in Biological Sciences (European mention, A *cum laude*)
- Post-graduate Spanish title (Tesina) in Biological Sciences (A).
- Bachelor (Licenciatura) in Biological Sciences (Ecosystems).

Scientific Career:

- Ikerbasque Associate (2022-)
- Professor Ramón y Cajal Fellow BC3-Basque Centre For Climate Change (2020-)
- Ramón y Cajal Fellow: BCAM- Basque Center for Applied Mathematics (2019-2020)
- Research Professor BC3-Basque Centre For Climate Change (2013-2019)
- Research Fellow: BC3-Basque Centre For Climate Change (2009-2013)
- Senior Researcher (BBSRC promotion): Institute of Grassland and Environmental Research, North Wyke Rs. (now Rothamsted Rs.) (UK). (2008-2009)
- Post-doc researcher: Institute of Grassland and Environmental Research (UK). (2002-2008)
- Junior Researcher: NEIKER (Spain) & AB-DLO (Wageningen, The Netherlands). (1997-2002)

Research Projects Experience and staff management (>50 projects):

- Project funding raised for BC3 (>1M€)
- WP leader in 4 EU projects (H2020, ERANET+ and FP7)
- PI of 3 R+D projects from the Spanish National R+D+I Plan
- Supervision of 5 postdoctoral researchers and 7 PhD students.

Development and coding of Mathematical Simulation Models (>10 models):

- 6 as first developer (e.g. $SIMS_{DAIRY}$, NGAUGE, NCYCLE_IRL, $LAND_{GHG}$, $SIMS_{NIC}$, SIM_{SR})

Publications:

- 59 articles in peer-reviewed international articles (>10 as first author).
- H index=30 (goggle scholar: https://scholar.google.com.sg/citations?user=jOaDpw0AAAAJ&hl=en)

Chapters in books (7 published)

- 7 international and 1 national (3 as first author).

Policy and Scientific technical reports (7 published)

- IPCC, UNEP, FAO, UK, EU, Spain, Ireland

Congresses (36 contributions, 28 international)

- 12 invited papers (9 as invited speaker, 3 key-note speaker).

Other important merits

- IPCC Lead Author (AFOLU) for the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
- Promotor/Coordinator/President of REMEDIA network (2012-2017)
- Member of organizing committee at 3 international workshops
- Scientific coordinator of "Zootechnic documents on N and P balances for cattle in Spain"
- Technical Advisory Group on Methane (FAO/LEAP)
- Elected member of the EU Focus group of EU-EIP Agri "Reducing emissions from cattle farming".
- Spanish representative in the Global Research Alliance on Agricultural GHG
- UK representative as young researcher on climate change research (British Council-CSIC).
- Leader of modeling group at North Wyke Research (2007-2008).
- Honorary Collaborator for Universidad de Miguel Hernández, (Alicante, Spain).
- Associate editor: ANIMAL, Grass and Forage Science, Frontiers.
- Scientific Coordinator of 4 advance courses on GHG and agriculture at IAMZ-CIHEHAM.

CURRICULUM VITAE AGUSTIN DEL PRADO_(EXTENDED)

1. PERSONAL

PROFFESIONAL

Current position	Professor Ramon & Cajal Fellow & Ikerbasque Associate
Institution	BC3-Basque Centre For Climate Change
Address	Edificio Sede Nº 1, UPV/EHU, Barrio Sarriena s/n | 48940 Leioa
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Researcher ID	B-4675-2010
ORCID	0000-0003-3895-4478
ResearchGate	https://www.researchgate.net/profile/Agustin-Del-Prado
Personal web	http://www.bc3research.org/agustin_del_prado.html

2. RESEARCH INTERESTS

With a PhD in Biology (2007) I have worked at BC3 since 2009, first as a fellow and then promoting as Research Professor (now under the Ramón y Cajal programme) and leading a small team on modelling in the area of climate change and agriculture. Before, I held a post-doc and then promoted to senior researcher positions at IGER, North Wyke Station (2002-2009) (currently Rothamsted Rs, UK).
My main objective has been to develop innovative mathematical simulations models (>10 models) in order to understand:

(i) the holistic effect of ruminants farming systems on climate change and potential for mitigation.
(ii) how climate change affect farm performance (productivity and environment) and strategies for climate change adaptation
(iii) the associated side-effects on sustainability attributes (e.g. economics, other pollutants, animal welfare, product quality, biodiversity…)
(iv) how experimental work at the animal and plant level can be translated at higher systems level (e.g. farm or regional level). Examples include: new plant/ animal breeds, novel feeding, etc.
(v) how to close nutrient loops by connecting livestock, feeding, food, waste management/treatment, bioenergy…

This work has been carried out through multi/interdisciplinary frameworks under the umbrella of competitive and commissioned R+D Sci. projects (EU:7, UK: 29, Spain:16), which I have coordinated (6) (e.g. Spanish National R+D or UK-DEFRA) or I have been WP leader (e.g. H2020 ISAGE, EU Optibarn, UK-DEFRA) and raised over 1million €. Most modelling work has been published in high impact journals and has been instrumental to provide policy-relevant information (e.g. IPCC-Lead Author, UNEP-report to protect Climate and the Ozone layer, Sci. coordination for Spanish national nutrient balances of cattle, member of EU-EIP Agri Focus group).
Networking with experimentalists and other disciplines (e.g. socio-economists) has been key. I promoted/initiated (coordinator/president: 2012-2017) the Spanish national sci. network REMEDIA on climate change mitigation from agriculture, livestock and forestry sectors. This resulted in numerous R+D outputs (e.g. workshops, projects, articles and special issues in Q1 international journals, dissemination activities, capacity building, etc…).

3. PROFFESIONAL EXPERIENCE

From Jan 2022 on: **Ikerbasque Associate** BC3-Basque Centre For Climate Change (Leioa, Spain).

From Jan 2020 on: **Professor & Ramón y Cajal Fellow** (funded by the 5 yr-Ramon y Cajal Programme grant for the recruitment of excellent posdoctoral researchers), BC3-Basque Centre For Climate Change (Leioa, Spain). RYC-2017-22143

Jan 2019-Dec 2019: Ramón y Cajal Fellow: BCAM- Basque Center for Applied Mathematics (Bilbao, Spain). RYC-2017-22143

Jan 2013- Dec 2018: **Research Professor**, BC3-Basque Centre For Climate Change (Bilbao, Spain).

Jan 2009- Dec 2012: Research Fellow, BC3-Basque Centre For Climate Change (Bilbao, Spain).

Jan 2008- Dec 2008: Senior Researcher (B5-SPD) (BBSRC promotion): North Wyke Research (now part of Rothamsted Res.) (Okehampton, UK).

May 2002- Dec 2007: **Post-doc Researcher (nutrient modeller**) (B6-PD). Institute of Grassland and Environmental Research (IGER), Okehampton (UK)

Jan 2001- May 2002: Junior Researcher (Fundación Cándido de Iturriaga y María de Dañobeitia). Instituto Vasco de Investigaciones Agrarias NEIKER, A.B (Derio, *Bizkaia,* Spain).

Jan 1999- Dec 2000: Junior Researcher (Gobierno Vasco de Agricultura y Pesca: formación de tecnólogos). Instituto Vasco de Investigaciones Agrarias NEIKER, A.B (Derio, Vizcaya, Spain) and AB-DLO (Wageningen, The Netherlands).

Sep 1997- Dec1998: Junior Researcher (INIA, introducción a la investigación). Instituto Vasco de Investigaciones Agrarias NEIKER, A.B (Derio, *Bizkaia*, Spain).

Sep 1996-Sep 1997: Undergraduate Research Assistant. Department of Human Biology (Universidad del País Vasco, Campus Leioa, Bizkaia, Spain).

4. ACADEMIC DEGREES

2007. PhD. Biological Sciences (European mention, A *cum laude*). Modelling approaches and measurements to study the effect of nutrient management on the sustainability of a dairy farm (Bilbao, UPV/EHU, Spain).

2000. Teaching Certificate. Certificado Aptitud Pedagógica. Universidad Complutense (Madrid)

1998. Postgraduate Thesis in Biological Sciences (*A)*. (Spanish grade: Tesina). Evaluación de las pérdidas de óxidos de N en un suelo de pradera. Grado de Sobresaliente en Ciencias Biológicas (Bilbao, UPV/EHU, Spain).

1997. BSc. Biological Sciences (Ecosystems) (Bilbao, UPV/EHU), Spain.

5. FURTHER STUDIES

Programming

2003. Delphi programming (Webtech, Painswick, UK).

2003. Visual Basic programming (Exeter College, Exeter, UK).

2002. Visual Basic for Applications (Okehampton, UK).

Biological Systems Modelling

1999. Postgraduate course: Systems Analysis and Simulation of Ecological Processes with examples in FST and FORTRAN. Wageningen University, Wageningen (The Netherlands).

1998. Postgraduate course: Principles and Applications of Cropping Systems Simulation Modelling (Universidad de Lleida, Solsona).

Other

2007. Supervisory Management Programme. (Roffey Park, Surrey, UK).
2007. Effective Recruitment and Selection course. (Moredun Research Institute, Edinburgh, UK).
2007. Diversity training course. (Okehampton, UK).
2007. Introduction to PRINCE 2 project management (UK).
2006. Safety management in a research environment (Okehampton, UK).
2006. Best practice in research supervision (Okehampton, UK).
2004. Introduction to project management (Okehampton, UK).
2004. Technical writing course (Okehampton, UK).
2001. Statistics for agriculture (multivariable analysis methods) Derio Agricultural Centre, (Spain).
2000. Geographical information systems (IDRISI). Derio Agricultural Centre, (Spain).
1998. Erosion control by using green buffers. Derio Agricultural Centre, Derio (Spain).

6. NATIONAL AND INTERNATIONAL RESPONSIBILITIES

2017-2019. IPCC Lead Author for 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Chapter 10 and 11).

2012-2017. President/coordinator/promoter of the Scientific Network on GHG mitigation from the agroforestry sector (agriculture, livestock and forestry) in Spain: RED REMEDIA

2016-. Scientific coordinator of Spanish Ministry document on N balances and CH4 emissions from dairy cattle in Spain.

2012-. Spanish representative in the Global Research Alliance on Agricultural GHG (livestock group, manure subnetwork).

2011. Elected to participate in international representation (as the Spanish scientific expert) in the mapping meeting of the core 5 (mitigation of GHG in agriculture) for the EU Joint Programming Initiative on Food Security, Agriculture and Climate Change (2021 June 2011, The Hague, Ministry of economics and Agriculture) http://www.faccejpi.com/

2008. UK and Spanish representative for: working group UK-Australasia British High Commission, LEARN network (2008)

2007. UK representative as young researcher on climate change research (British Council CSIC). (2007)

2016-2017. Focus group member of EU-EIP Agri "Reducing emissions from cattle farming" topic.

7. PUBLICATIONS

7.1. *ARTICLES IN INTERNATIONAL PEER-REVIEWED JOURNALS*

Summary: 59 articles (SCOPUS), h index=30 (Goggle scholar), 24 (Scopus), 3105 cites (goggle scholar) 1743 (Scopus) {16/7/2022} Scopus Author ID: 6701755151.

A selection of articles is shown below. For full list see annex:

- Pardo G, del Prado A, Fernández-Álvarez J, Yáñez-Ruiz DR and Belanche A 2022. Influence of precision livestock farming on the environmental performance of intensive dairy goat farms. Journal of Cleaner Production 351, 131518.
- Domínguez IP, Prado A del, Mittenzwei K, Hristov J, Frank S, Tabeau A, Witzke P, Havlik P, Meijl HV, Lynch J, Stehfest E, Pardo G, Barreiro-Hurle J, Koopman J and Sánchez MJS 2021. Different appreciations of methane's global warming potential may affect the cost-effectiveness of carbon pricing and low-meat diets. Nature Food (with minor corrections at 4/09/2021).

- Pardo G and del Prado A 2021. A simple model for the effect of thermal stress on the productivity of small ruminants. *Livestock Science* 251, 104649.
- Del Prado A del, Manzano P and Pardo G 2021. The role of the European small ruminant dairy sector in stabilising global temperatures: lessons from GWP* warming-equivalent emission metrics. *Journal of Dairy Research* 88, 8–15.
- Pardo, G., del Prado, A., Martínez-Mena, M., Bustamante, M. A., Martín, J. R., Álvaro-Fuentes, J., & Moral, R. (2017). Orchard and horticulture systems in Spanish Mediterranean coastal areas: Is there a real possibility to contribute to C sequestration?. *Agriculture, Ecosystems & Environment*. 238: 153–167.
- Pardo G, Moral R and del Prado A. 2017. SIMSWASTE-AD - A modelling framework for the environmental assessment of agricultural waste management strategies: Anaerobic digestion. *Science of The Total Environment*, 574:806–817.
- Del Prado,A., Corré WJ, Gallejones. P., Pardo, G., Pinto M, del Hierro O. and Oenema O. 2016. NUTGRANJA 2.0: a simple mass balance model to explore the effects of different management strategies on nitrogen and greenhouse gases losses and soil phosphorus changes in dairy farms. *Mitigation And Adaptation Strategies For Global Change*. 21(7), 1145–1164
- Gallejones, P. , Aizpurua A. , Ortuzar-Iragorri,M.A. and del Prado,A. 2016. Development of a new model for the simulation of N_2O emissions: a case-study on wheat cropping systems under humid Mediterranean climate. *Mitigation And Adaptation Strategies For Global Change.* 21(7), 1107–1130.
- Pardo G, Moral R, Aguilera E, del Prado A. 2015. Gaseous emissions from management of solid waste: A systematic review. *Global Change Biology.* 21, 1313-1327.
- Gallejones P., Pardo G., Aizpurua A., del Prado A. 2015. Life cycle assessment of first-generation biofuels using a nitrogen crop model. *Science of the Total Environment*.1, 1191–1201.
- Sanz-Cobena, A., Lassaletta, L., Estellés, F., Del Prado, A., Guardia, G., Abalos, D., Aguilera, E., Pardo, G., Vallejo, A., Sutton, M.A., Garnier, J., and Billen, G. 2014. Yield-scaled mitigation of ammonia emission from N fertilization: the Spanish case. *Environmental research letters*. 9, 125005.
- Del Prado A, Mas K, Pardo G., Gallejones. P. 2013. Modelling the interactions between C and N farm balances and GHG emissions from confinement dairy farms in northern Spain. Science of The Total Environment. 465, 156-165.
- Del Prado A., Crosson P., Olesen J.E. and Rotz A. 2013. Whole-farm models to quantify GHG emissions and their potential use for linking climate change mitigation and adaptation in temperate grassland ruminant-based farming systems. *Animal.* 7 (suppl.2), 373-385.
- Del Prado A., Misselbrook T, Chadwick D, Hopkins A, Dewhurst R.J., Davison P., Butler A., Schröder J., and Scholefield D. 2011. SIMSDAIRY: A modelling framework to identify sustainable dairy farms in the UK. Framework decription and test for organic systems and N fertiliser optimisation. *Science of the Total Environment* 409 (19): 3993-4009.
- Del Prado A., Chadwick D., Cardenas L., Misselbrook T., Scholefield D. and Merino P. 2010. Exploring systems responses to mitigation of GHG in UK dairy farms. Agriculture, Ecosystems and Environment. 136 (3-4): 318-332.
- Del Prado, A. and Scholefield, D. 2008. Use of SIMSDAIRY modelling framework system to compare the scope on the sustainability of a dairy farm of animal and plant genetic-based improvements with management-based changes. Journal of Agricultural Science 146: 195-211. 2007.
- Hopkins A. and del Prado A. 2007. Implications of climate change for grassland management: impacts, adaptations and mitigation options: a review. Grass and Forage Science 62 (2): 118-126.

- Del Prado A., Brown L., Schulte R., Ryan M. and Scholefield D. 2006. Principles of development of a mass balance N cycle model for temperate grasslands: an Irish case study. Nutrient cycling in Agroecosystems 74: 115-131.
- Del Prado A., Merino P., Estavillo J.M., Pinto M. and González-Murua C. 2006. Nitrous and nitric oxide emissions from different N sources and under a range of soil water contents. Nutrient cycling in Agroecosystems 74: 229-243.
- Brown L., Scholefield D., Jewkes E.C., Lockyer D.R. and del Prado A. 2005. NGAUGE: a decision support system to optimise N fertilisation of British grassland for economic and/or environmental goals. Agriculture, Ecosystems and Environment. 109: 20-39.

7.2. OTHER RELEVANT PUBLICATIONS

International UN reports

- FAO. In press. Methane Emissions in Agriculture - sources, quantification, mitigation and metrics. Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.
- Gavrilova O., Leip A., Dong H., MacDonald D.J, Gomez-Bravo C.A., Amon B., Barahona-Rosales R., Del Prado A., De Lima M. A., Oyhantcabal W., Van der Werden T and Widiawati Y. 2019. Emissions from livestock and manure management. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse gas Inventories. IPCC Intergovernmental Panel on Climate Change, Geneva, pp. 10.1–10.225. https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch10_Livestock.pdf
- Hergoualc'h, K., Akiyama, H., Bernoux, M., Chirinda, N., del Prado, A., Kasimir, Å., MacDon-ald, D., Ogle, S.M., Regina, K., and Van der Werden T. 2019.N2O emissions from managed soils, and CO2 emissions from lime and urea application. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse gas Inventories. IPCC Intergovernmental Panel on Climate Change, Geneva, pp. 11.1–11.48. https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch11_Soils_N2O_CO2.pdf .
- UNEP 2013. Drawing down N2O to protect Climate and the Ozone layer. A UNEP synthesis report. United Nations Environment Programme (UNEP), Nairobi, Kenya Download

Book chapters (a selection of 16, whole list in Annex)

- Calvet S., Estellés F, del Prado A and Groenestein K. in press. Modelling methane emission from manure In: Technology for Environmentally Friendly Livestock Production. Springer.
- Scholefield D. and del Prado A. Biodiversity and systems Research: $SIMS_{DAIRY}$: a novel modelling framework to specify routes towards sustainability of UK dairy farms. Wilkins, R.J., Jarvis, S.C. and Blackwell, M.S.A. (Eds.). The H. 2009. In North Wyke Story: 60 Years of Grassland Research, 1949-2009. North Wyke Research, Okehampton, Devon. p 78
- Merino P; González-Murua C; Del Prado A; Menéndez S; Pinto M; Estavillo JM. 2008 Grassland contribution to climate change in the Basque Country. Opportunities to mitigation. Grasslands: Ecology, Management and Restoration (Book). Chapter 9.2008. ISBN 978-1-60692-024-4
- Del Prado, A.; Scholefield, D.; Brown, L.A model to simulate the effects of different dietary strategies on the sustainability of a dairy farm system. Nutrient Digestion and Utilization in Farm Animals: Modelling Approaches. pp. 275 - 280. CAB international, 2006.
- Del Prado, A.; Scholefield, D.; Chadwick, D.; Misselbrook, T.; Haygarth, P.; A. Hopkins; R. Dewhurst; P. Davison;E. Lord; M. Turner. A modelling framework to identify new integrated dairy

production systems. Grassland Science in Europe. 11, pp. 766 - 768. European Grassland Federation, 2006.

- Del Prado, A.; Cardenas, L.; Scholefield D.2006. Impact of NO3 leaching abatement measures on N2O and CH4 emissions from a UK dairy system. International Congress Series. 1293, pp. 359 - 362. Elsevier, 2006.
- Hopkins; A. Del Prado. 2006. Implications of climate change for grassland: impacts, adaptations and mitigation options. Grassland Science in Europe. 11, pp. 749 - 759. European Grassland Federation, 2006.
- Del Prado, A.; Sholefield, D.2006. Use of $SIMS_{DAIRY}$ modelling framework system to specify sustainable UK dairy farms. Aspects of Applied Biology. Delivering Sustainability within profitable faming systems- is it possible?. 80.
- del Prado, A; Brown, L.; Scholefield, D. 2004. NGAUGE DSS as a tool to assist UK dairy farmers to comply with EU nitrate legislation. Controlling Nitrogen Flows and Losses. pp. 423 - 424. 2004.

Other reports (peer reviewed) (a selection, full list in Annex)

- Del Prado, A., Manzano, P., 2020. La ganadería y su contribución al cambio climático. Muñoz, A. (ed). Amigos de la Tierra y BC3, Madrid y Leioa. https://www.tierra.org/wp-content/uploads/2020/09/Informe-Ganaderia-Cambio-climatico-Amigos-de-la-Tierra.pdf
- Del Prado A., Baucells J. Casasús I. and Fondevila M. 2019. Bovino: Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y de fósforo. Publisher: Ministerio de Agricultura, Pesca y Alimentación. MAdrid, 906 págs. ISBN: NIPO: 003-19-237-4 (papel) NIPO: 003-19238-X (línea) Depósito Legal: M-37409-2019 https://bit.ly/2B3ADtd
- Del Prado A, Batalla I, Pardo G, Galán E, Thomas C, Ragkos A, Theodoridis A and Arsenos G 2020 Deliverable 4.4 Project EU ISAGE. New trajectories towards innovative sheep and goat production systems.
- Del Prado A, Batalla I, Pardo G, Jebari A, Ragkos A, Alexandros T and Arsenos G 2019 Deliverable 4.3. Project EU ISAGE. New holistic model that can be used to redesign terrestrial small ruminant's livestock systems. https://www.isage.eu/wp-content/uploads/D4.3_Holistic-farm-model.pdf
- Estellés F, Calvet Sanz S, Llonch P, Belanche A, Yáñez-Ruiz D, Arriaga H, Merino P, Ruiz R, Mandaluniz, Albizyu I, Batalla I, del Prado A, Pardo G, Gonzalez-Recio O, Reyes C, Díaz C and Rodríguez-Estévez V. 2020. Código de buenas prácticas medioambientales PROVACUNO. http://www.provacuno.es/v_portal/inc/clicklink.asp?t=3&cod=1691&c=257&s=347355456
- Moran D., Topp K., Wall E., Wreford A., Chadwick D., Hall C., Hutchins M., Mitchell M., del Prado A., Tolkamp B. and Wu L. 2009. Climate Change impacts on the livestock sector. Final Report DEFRA AC0307.2009.
- Del Prado A., Scholefield D. and Chadwick D. 2009. New integrated dairy production systems: specification, practical feasibility and ways of implementation. Final Report DEFRA IS0214.
- Del Prado A., Scholefield D. and Brown L. NCYCLE_IRL. 2007.A model to predict N fluxes in Irish grasslands. Technical Report. Environmental Protection Agency. An Ghniomhaireacht um Chaomhnu Comhshaoil PO Box 3000, Johnstown Castle, Co. Wexford, Ireland.

Policy-oriented articles (a selection, full list in Annex)

- Del Prado, A; Aaes, O.; Bartzanas, T.; Bossin , S.; Calvet, S.; Demeyer, P.; Grudovska, I.; Misselbrook, T.; Van Dongen, C.2017. Farm models/tools to help farmers reducing emissions. Mini-

papers EIP-AGRI Focus Group Reducing livestock emissions from Cattle farming. EIP-AGRI, 2017. Available on-line at: https://ec.europa.eu/eip/agriculture/sites/agri-eip/files/fg18_mp_model_and_tools_2017_en.pdf

- Sanz-Cobena, A., Lassaletta, L., Estellés, F., Del Prado, A., Guardia, G., Abalos, D., Aguilera, E., Pardo, G., Vallejo, A., Sutton, M.A., Garnier, J., and Billen, G. 2015. Agricultural ammonia emissions could be reduced without affecting crop yield. *Science for Environment Policy*. Issue 414. (21-5-2015).
- Cardenas L.M., Cuttle S.P.,Crabtree B., Hopkins A., Shepherd A. Scholefield D. and del Prado A. 2011. Land management changes required to tackle nitrate pollution. *Science for Environment Policy*. Issue 236. (8-4-2011).
- Del Prado A. and Sanz MJ. 2016. Implicaciones del Acuerdo de París en los sectores relacionados con los usos de la tierra, cambios de uso de la tierra y la silvicultura. *Ambienta: La revista del Ministerio de Medio Ambiente* 114, 84-95.

8. CONGRESSES AND CONFERENCES

Summary: >70 contributions, 14 key-note speeches, 71 oral/posters.

Relevant examples as key-note speaker

- Del Prado A. 2021 Linking the concept of GWP* Livestock in grassland-based livestock systems for climate impact assessments. Evolving Foodscapes and Thoughtscapes https://www.multiscapes.co.nz/
- Del Prado A. 2020. Indicadores y métricas ambientales para analizar la sostenibilidad de la ganadería rumiante. 43 Congreso Argentino de Producción Animal
- Del Prado A. 2019. Climate change impacts on Mediterranean small ruminant production systems and mitigation options. Key-note speech. Joint Meeting of the FAO-CIHEAM Network for Research and Development in Sheep and Goats (Subnetworks on Nutrition and Production Systems) and the FAO-CIHEAM Subnetwork for the Research and Development of Mediterranean Pasture and Forage Resources Meknès (Morocco), (23-25/10/2019) http://networks.iamz.ciheam.org/meknes2019/en/programme.php
- A del Prado. 2018. Key-note presentation. Addressing climate change mitigation potential in agriculture, presented at the International Conference on Agricultural GHG Emissions and Food Security -Connecting research to policy and practice, organized by Thünen institute, Berlin, Germany, Sep, 2018. https://www.agrighg-2018.org/
- Del Prado A 2014. Key-note presentation with co-authors (van den Pol-van Dasselaar, Chadwick D., Misselbrook T, Sandars D, Audsley E, Mosquera-Losada MR.) Synergies between mitigation and adaptation to Climate Change in grassland-based farming. 25th European Grassland Federation EGF, 7-11 September 2014, Aberystwyth, UK.
- Del Prado A. 2013. Key-note presentation with co-authors (Crosson P., Olesen J.E., and Rotz A.) Whole-farm models to quantify greenhouse gas emissions and their potential use for linking climate change mitigation and adaptation in temperate grassland ruminant-based farming systems. Greenhouse Gases and Animal Agriculture Conference (GGAA 2013), 26 June 2013, Dublin, Ireland. http://www.ggaa2013.ie
- Del Prado A. 2010. The effect of intensive livestock production on air, soil and water. Workshop: Soil property dynamics under different land uses and management (Dinámica de las propiedades del suelo bajo diferentes usos y manejos), INIA-Uruguay (Uruguay).

9. R&D PROJECTS FUNDED THROUGH COMPETITIVE CALLS OR NON-COMPETITIVE CONTRACTS OF PUBLIC/ PRIVATE ENTITIES

At the BC3 (since 2009), I have raised **project funding for BC3 for over 1 million €** and I have built a team (currently **4 postdoctoral researchers, 2 PhD students) obtaining my own funds for this**. Additionally, while at BC3, I raised funding for about €15000 as president/promoter of REMEDIA network for dissemination activities (e.g. Ist workshop, website). Before, at IGER, I became group leader of a small modelling team in my last year (2008) and become the IGER-PI of a number of DEFRA-UK, EU and Irish projects. Most projects funding have been through competitive calls at EU or national levels. Additionally, I have also raised funding as contracted/subcontracted for other research centres (e.g. Rothamsted Rs) or private entities (e.g. NGOS: Friends of the Earth, dairy sector: CAPSA, Global Dairy Platform). ***A selection of projects and roles are provided below (See annex for full list):***

WP leader in 3 EU projects

- **ISAGE**. 2016-2019. Innovation for Sustainable Sheep and Goat Production in Europe. EU H2020 SFS-01c-2015 - Assessing sustainability of terrestrial livestock production (WP3 leader, Task 3.3 and 4.3 leader; member of Executive board) **[Total 7 M€, BC3: 0,5 M€]**
- **OPTIBARN**. 2014-2017. Optimized animal-specific barn climatization facing temperature rise and increased climate variability. EU ERANET +, EU FACCE JPI (WP4 leader). **[Total 1,1 M€, BC3: 0,15M€]**
- ANAEE. 2008-2010. Structuring Infrastructures for the Analysis and Experimentation on Ecosystems (ANAEE). EU, FP7. http://cordis.europa.eu/result/rcn/45701_en.html. (1 year until my IGER exit). **[Total: 1,07M€]**

Coordinator in 3 R+D projects from the Spanish National R+D+I Plan

- Manure management GHG and NH_3 effects in dairy systems. 2017-2019. INIA RTA2015-00058-C06-05 **[BC3: 60K€]**
- NEREA5-Modelling gaseous N and C emissions using DNDC in order to obtain emission factors under different agricultural practices. 2013-2015. Convocatoria Plan Nacional de investigación fundamental no-orientada. AGL2012-37815-C05-04 **[BC3: 16K€]**
- LANDGHG-Developing system-based mitigation strategies to reduce GHG within and between multifunctional land-use elements of a landscape. 2010-2012. Convocatoria Plan Nacional de investigación fundamental no-orientada. CGL2009-10176 **[Total, BC3: 62K€].**

Theme leader-Strategic Programme at Institute of Grassland and Environmental Research (IGER) (UK)

- ISPG-BBSRC. 2008-2011. "Developing a systems-based modelling approach to understanding and predicting consequences of grassland soil managements for atmosphere and water environments (incorporating energy and carbon into the systems functional units)". (1 year until my IGER exit).

Coordinator in 1 R+D projects from DEFRA (UK):

- New integrated dairy production systems: specification, practical feasibility and ways of implementation. 2004-2007. DEFRA IS0214 (official coordination during the last year). **[Total: 0,55M€]**

WP leader in 1 R+D +D projects from DEFRA (UK):

- Cost curves for multiple diffuse pollutants, NH3 and GHG emissions on farms-FARMSCOPER. WQ0106 (WP3 leader) (1 year until my IGER exit). **[Total: 1,4M€]**

Coordinator in 2 R+D regional projects from the Basque Government:

- ENERKROP-Development and application of agronomic models in order to evaluate environmental sustainability of bioenergy cropping Systems in the Basque Country. 2014. SAIOTEK Programme. Dep. Industria, Innovación, Comercio y Turismo; Gobierno Vasco. S-PE13BC002 **[Total, BC3: 50K€]**

- ECOAGRIWASTE-Development of a modelling framework to evaluate the most efficient use of agro-food industrial waste in the context of GHG emission mitigation). Department of Education, Universities and Research of the Basque Country PC2010-33A **[Total: 17K€, BC3: 7K€]**

PI in R&D non-competitive projects with private entities

- Global Dairy Platform 2021.: GWP*/GWP-we evaluation for cattle and buffaloes methane emissions: **[Total, BC3: 20K€]**
- CAPSA. 2020-2021. Project on assessing the potential of feed additives to mitigate climate change in dairy cattle farming. **[Total, BC3:** 5616 €**] (PI)**

10. INDIVIDUAL GRANTS

2022. FUNDACION IKERBASQUE. permanent position as an Ikerbasque Research Associate. 50K€/year
2022. FUNDACION IKERBASQUE IKERBASQUE START UP 20K€
2019. Ramón y Cajal (RYC) RYC-2017-22143. Contracts Aids (AYUDAS RAMÓN Y CAJAL CONVOCATORIA 2017). €208600. Grantholder: Agustin del Prado
2001. Fundación Cándido de Iturriaga y María de Dañobeitia €20434 Grantholder: Agustin del Prado
1999-2000. R+D grant for the agrarian, agro-food and fisheries sectors (beca de investigación y desarrollo en los sectores agrario, agroalimentario y pesquero) €18.000 Grantholder: Agustin del Prado
1998. Introduction to research (3 months). Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria. €1800. Grantholder: Agustin del Prado
In 2008 I was selected for INIA-doc National Programmes (2008) National Programmes and ranked 1st in Juan de La Cierva (2008) National Programmes, but I did not accept the grants.

11. DEVELOPMENT OF MATHEMATICAL SIMULATION MODELS

My modelling work has included the development of integrated systems modelling approaches in order to advance fundamental understanding of complex land use systems to underpin practical solutions to major challenges. This approach accounts for synergies of feedback and feed-forward interactions between climate change, agriculture, water, land use change, and food and energy production. My achievements have used a 'Systems modelling' approach within the strategic priority area of Climate Change, Agriculture and Food Security.

My systems modelling involves in-depth understanding of:

(i) plant, soil and animal biology and the mechanisms of nutrient and energy flows and losses through these system components.
(ii) how the components of this complex system interact.
(iii) the capability to express (i) and (ii) in a mathematical framework.
(iv)the necessary expertise in a high-level programming language to produce a usable computer simulation of system dynamics (DELPHI PASCAL and Visual Basic).
(v) the capability to create robust approaches that are useful as scientific evidence for policy and socio-economic studies.

Below, I include a selection of mathematical models that I have been involved with, some being the main developer.

A selection of models is provided below (See annex for full details):

-A whole-farm model in order to assess sustainability trajectories from small ruminant production systems in Europe

Developers: del Prado A., G. Pardo, I. Batalla, A. Jebari
Basque Centre For Climate Change (BC3)
Programmed in DELPHI PASCAL
Funded by H2020 EU project https://www.isage.eu/
Description published online as a project deliverable: https://www.isage.eu/wp-content/uploads/D4.3_Holistic-farm-model.pdf

SIMS$_{NIC}$- A new simple cropping model for predicting GHG and N losses from wheat and rapeseed cropping systems.

Developers: del Prado A., Gallejones P, Aizpurua A, Ortuzar-Iragorri M.A
Basque Centre For Climate Change (BC3)
Programmed in DELPHI PASCAL
Funded by Spanish National R + D + i Plan (CGL2009–10,176, AGL2012–37,815–C05–04) and part of Patricia Gallejones´s PhD thesis (Gallejones P, 2015)
Description published online as scientific article: https://link.springer.com/article/10.1007/s11027-014-9563-6 (Gallejones et al., 2016*; Mitigation and Adaptation Strategies for Global Change*)
Application online as scientific article: (Gallejones et al., 2015; *Science of the Total Environment* https://doi.org/10.1016/j.scitotenv.2014.10.061)

SIMS$_{WASTE}$- A modelling framework for assessing GHG emissions from treatment of livestock manure and other organic waste (bio-digestion and composting)

Developers: Pardo G, del Prado A., Moral R.
Basque Centre For Climate Change (BC3)
Programmed in Visual Basic
Funded by Spanish National R + D + i Plan (CGL2009–10,176, AGL2012–37,815–C05–04)
and part of Guillermo Pardo´s PhD thesis (Pardo, 2016)
Description published online as a scientific article: (Pardo et al., 2017a*; Science of the Total Environment https://doi.org/10.1016/j.scitotenv.2016.09.096)*
Application online as scientific article: (Pardo et al., 2017b*; Agriculture Ecosystems and Environment* https://doi.org/10.1016/j.agee.2016.09.034)

ROTHC version for GIS studies-An excel based version

Developers: Pardo G, Jebari A, del Prado A.,
Basque Centre For Climate Change (BC3)
Programmed in Visual Basic for EXCEL
Funded by "Fundación Candido de Iturriaga y Maria Dañobeitia" and part of Asma Jebari's PhD thesis (to be defended in 2021).
Description and application published online as a scientific article: (Jebari et al., 2018*; Journal of Environmental Quality* https://doi.org/10.2134/jeq2017.07.0294 *)*

ROTHC version for Atlantic grasslands

Developers: Jebari A, del Prado A., Pardo G, Alvaro-Fuentes J
Basque Centre For Climate Change (BC3)
Programmed in Visual Basic for EXCEL

Funded by ISAGE project Europe (iSAGE)" H2020 No 679302 and "Fundación Candido de Iturriaga y Maria Dañobeitia" and part of Asma Jebari's PhD thesis (to be defended in 2021) .

Description published online as a scientific article: (Jebari et al., 2021*; Plos One* https://doi.org/10.1371/journal.pone.0256219 *)*

A simple model for the effect of thermal stress on the productivity of small ruminants

Developers: Pardo G, del Prado A.
Basque Centre For Climate Change (BC3)
Programmed in Visual Basic for EXCEL
Funded by ISAGE project Europe (iSAGE)" H2020 No 679302

Description published online as a scientific article: (Pardo &Del Prado (2021)*; Livestock Science* https://doi.org/10.1016/j.livsci.2021.104649*)*

SIMSDAIRY- a modelling framework to identify new integrated dairy production systems
Developers: del Prado A. y Scholefield D.
IGER, North Wyke Research, DEFRA (Reino Unido).
Programmed in DELPHI PASCAL
Funded by DEFRA IS0214

Description published online as a scientific article: (Del Prado et al., 2011*; Science of the Total Environment https://doi.org/10.1016/j.scitotenv.2011.05.050)*
Applications online as scientific articles: Del Prado &Scholefield 2008; *The Journal Of Agricultural science* doi:10.1017/S0021859608007727; Del Prado et al. 2010 *Agriculture Ecosystems and Environment* https://doi.org/10.1016/j.agee.2009.09.015 .

NUTGRANJA - a model to explore the effects of different management strategies on N and P losses from dairy systems.
Developers: del Prado A., Oenema O., Corre W.
NEIKER (Derio, Vizcaya, Spain), ABDLO (Wageningen, The Netherlands).
Programmed in DELPHI PASCAL
Funded by National R+D+i Plan (CGL2009-10176) and Department of Education, Universities and Research of the Basque Country (PC2010-33A).
Description published online as a scientific article: (Del Prado et al., 2016 *Mitigation and Adaptation Strategies for Global Change https://link.springer.com/article/10.1007/s11027-014-9598-8)*

N Gauge a decision support system to optimise N fertilisation of British grassland for economic and/or environmental goals.
Developers: Brown L., Lockyer D, del Prado A. y Scholefield D.
IGER, North Wyke Research, DEFRA (UK).
Programmed in DELPHI PASCAL
Funded by DEFRA NT1601, NT1603
Description published online as a scientific article: (Brown et al., 2005 *Agriculture Ecosystems and Environment https://doi.org/10.1016/j.agee.2005.02.021)*

Application online as scientific article: (Cardenas et al., 2011*; Science of the Total Environment* https://doi.org/10.1016/j.scitotenv.2010.12.006)

- a model to predict N fluxes in Irish grasslands.
Developers: del Prado A., Brown L. y Scholefield D.
TEAGASC (Irland), IGER (UK).
Programmed in DELPHI PASCAL
Funded by EPA Ireland Eutrophication from Agriculture Sources 2000-LS-2-M2
Description published online as a scientific article: (Del Prado et al., 2006 *Nutrient Cycling of Agroecosystems https://link.springer.com/article/10.1007%2Fs10705-005-5769-z)*

12. R&D MANAGEMENT AND PARTICIPATION IN SCIENTIFIC COMMITTEES

12.1. SCIENTIFIC, TECHNICAL AND/OR ASSESSMENT COMMITTEES

2019-2022. Scientific advisor for EU ERANET MILKEY project. Reference Number: 39288. https://www.milkey-project.eu/
2017-2019. IPCC Lead author for "2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories".
2013. Advisor for improving the N_2O emission calculation method for dairy cattle farming in the Netherlands.
2008. UK representative for working group UK-Australasia- British High Commission on GHG mitigation from the agricultural sector.
2016- currently. Scientific coordinator of Zootechnic documents on N and P balances for cattle in Spain. MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACION
2011-currently Spanish representative for Global Research Alliance on Agricultural GHG emissions (Livestock, manure network) MINISTERIO DE AGRICULTURA, PESCA Y ALIMENTACION

12.2. ORGANISATION AND MANAGEMENT OF R&D ACTIVITIES

Scientific Network promoter

President/coordinator/promoter of the Scientific Network on GHG mitigation from the agroforestry sector (agriculture, livestock and forestry) in Spain: RED REMEDIA (2012-2017) https://redremedia.org/
As this is one of my biggest merits, I included additional information in the annex.

Courses

2019-2020. Coordinating and lecturing in these for 4 one-week advanced courses for highly qualified professional and PhDs within the IAMA-CIHEAM courses (supported with grants for attendants from developing countries by FAO and Global Research Alliance amongst other bodies).
2019. Co-organiser of Training school on measuring GHG in agricultural systems at Lugo 28th-29th March (RED NUEVA & cost-action LIVAGE).

International conferences/workshops

2022. Organiser of modelling workshop for the 8th International Greenhouse Gas and Animal Agriculture Conference (GGAA), Florida (USA). June 5-10, 2022.
2014. Member of organising committee of International Livestock Modelling and Research Colloquium MACSUR (LiveM) Bilbao, Basque Country, Spain.
2012. Member of organising committee of 1st mapping meeting of FACCE JPI (Joint Programming Initiative on Agriculture, Food Security and Climate Change) for Core theme 4: Adaptation to

climate change. Mapping meeting Geographical area: European Union, INIA, Madrid, Community of Madrid, Spain.
2003. Member of organising committee of 12th N workshop (organiser of decision support systems session). Institute Of Grassland and Environmental Research, Exeter, United Kingdom.

National workshops

Main organizer
2015. Organisation of Workshop Policy Briefing-Butron (Top 10 Mitigation measures for N2O in Spain) Type of activity: Coordinator Geographical area: National, Butrón, Basque Country, Spain.
2012. President/coordinator of I Workshop on mitigation of GHG emissions from the Spanish Agroforestry sector, Bilbao, Basque Country, Spain.
Organising and Scientific committee
2015. IV Workshop on mitigation of GHG emissions from the Spanish Agroforestry sector. Universidad Politécnica de Madrid, Madrid, Community of Madrid, Spain.
Scientific committee
2020. VIII Workshop on mitigation of GHG emissions from the Spanish Agroforestry sector (online). Universidad Miguel Hernández de Elche, Spain.
2019. VII Workshop on mitigation of GHG emissions from the Spanish Agroforestry sector. Lugo, Universidad de Santiago de Compostela (Campus de Lugo), Spain.
2017. V Workshop on mitigation of GHG emissions from the Spanish Agroforestry sector. IRTA, Caldes de Montbui, Spain.
2015. KLIMAGUNE workshop (Communicating climate science: Opportunities and challenges), Bilbao, Basque Country, Spain.
2014. KLIMAGUNE workshop (Opportunities and challenges for rural areas in the context of climate change), Bilbao, Basque Country, Spain.
2014. III Workshop on mitigation of GHG emissions from the Spanish Agroforestry sector, Universidad Politécnica deValencia. Valencia, Valencian Community, Spain
2013. KLIMAGUNE workshop (Opportunities, Challenges and Barriers for Transitions Towards Sustainability in the Context of Climate Change), Bilbao, Basque Country, Spain.
2013. II Workshop on mitigation of GHG emissions from the Spanish Agroforestry sector. Estación Experimental de Aula Dei, Zaragoza, Aragon, Spain.
2012. KLIMAGUNE workshop (De Euskadi a Rio + 20), Bilbao, Basque Country, Spain.

12.3. EVALUATION OF R&D PROJECTS AND STUDIES

I have been reviewer for H2020 and FP7 programme project calls, Marie-curie and mid-term project reviewer. Regularly I have assessed and reviewed R&D projects at the national level for different countries (e.g. for Spain >50 for Spanish National research Agency). I am a regular reviewer for many scientific journals.

12.4. MEMBER OF NETWORKS

2008-2009. The International Environmental Modelling and Software Society
2008. South West Environmental modellers
2004-2009. Society of UK agricultural modellers
2009. Red de Uso Eficiente del Nitrógeno en Agricultura (RUENA) (Efficient Use of N in Agriculture Network)
2010. Red Española de Compostaje (REC)
2012. REMEDIA network

2012. Global DNDC network
2012. FACCE JPI MACSUR Knowledge Hub
2012- Manure management network (Global Research Alliance on GHG emissions from agriculture)
2013-. Sociedad española de PAstos (SEEP)
2014. GRAMP Review of Available Resources and Experimental Databases for modelling N2O emissions from agricultural systems.
2018. RED NUEVA. PI.

12.5. OTHER MANAGEMENT DUTIES

2016-2019. I was coordinating the individual evaluation process -HR Excellence process at BC3
2014-. Member of Management Committee at BC3
2008. Management-Leader of modeling group at North Wyke Research (currently Rothamsted Rs)
I have been Associate Editor of Grass and Forage Science (2009-2018), ANIMAL (2016-2019) and Frontiers in Sustainable Food and Agriculture (2017-) Journals. I was an invited editor for the

13. STAFF MANAGEMENT AND PHD/MSC/GRADE SUPERVISION

I have managed and mentored PhD, MSc and grade students, visitors and Postdoctoral researchers. For this, I have received several training in improving my supervision capacities. During my period at IGER (UK) I supervised a Postdoc researcher (Dr. Anita Shepherd) for the last year, coinciding with my role as thematic leader of one of the Strategic Programmes on Modelling of the IGER institute.
Since 2009 at the BC3 I have supervised 4 postdocs (3 under EU projects and 1 with a JdC Spanish grant position) and 3 successful PhD students (P. Gallejones ,G. Pardo and A Jebari). G. Pardo's thesis has been recently awarded as the best thesis for Climate Change studies in the Spanish Mediterranean area https://www.iiama.upv.es/iiama/es/sala-prensa/noticias/guillermo-pardo-ganador-del-premio-a-la-mejor-tesis-doctoral-de-la-catedra-de-cambio-climatico.html and P Gallejones, A. Jebari and G. Prado successfully developed different mathematical models (e.g. $SIMS_{NIC}$ and $SIMS_{WASTE}$), applying such models in strategic studies. Both Theses led to high impact publications (see below, Q1: quartile 1, D1: decile1 in their areas). Currently, I am supervising 2 PhD students (Lucas Yamat and Xabier Diaz de Otalora). Some publications from ongoing and finished PhDs are shown below:

1. Díaz de Otálora X, del Prado A, Dragoni F, Estellés F and Amon B 2021. Evaluating Three-Pillar Sustainability Modelling Approaches for Dairy Cattle Production Systems. Sustainability 13, 6332.
2. Jebari A, Álvaro-Fuentes J, Pardo G, Almagro M and Prado A del 2021. Estimating soil organic carbon changes in managed temperate moist grasslands with RothC. PLOS ONE 16, e0256219.
3. Jebari, A., del Prado, A., Pardo, G., Rodríguez Martín, J.A., Álvaro-Fuentes, J., 2018. Modeling Regional Effects of Climate Change on Soil Organic Carbon in Spain. Journal of Environment Quality 0, 0. https://doi.org/10.2134/jeq2017.07.0294.
4. Gallejones, P. et al. 2016. Development of a new model for the simulation of N_2O emissions: a case-study on wheat cropping systems under humid Mediterranean climate. ***Mitigation And Adaptation Strategies For Global Change***. 21(7), 1107–1130
5. Gallejones, P. et al. 2012. Nitrogen and sulphur fertilization effect on leaching losses, nutrient balance and plant quality in a wheat-rapeseed rotation under a humid Mediterranean climate. ***Nutrient Cycling In Agroecosystems***. 93. (3) 337 - 355.

6. Gallejones, P. et al. 2015. Life cycle assessment of first-generation biofuels using a nitrogen crop model. ***Science of the Total Environment***.1, 1191–1201
7. Pardo et al. 2017. Orchard and horticulture systems in Spanish Mediterranean coastal areas: Is there a real possibility to contribute to C sequestration? ***Agriculture, Ecosystems & Environment.*** 238: 153-167
8. Pardo et al. 2015. Gaseous emissions from management of solid waste: A systematic review. ***Global Change Biology***. 21, 1313-1327
9. Pardo et al. 2017. SIMSWASTE-AD - A modelling framework for the environmental assessment of agricultural waste management strategies: Anaerobic digestion. ***Science of The Total Environment,*** 574:806–817.
10. Pardo et al. 2016. Greenhouse gas mitigation potential of including agro-industrial by-products in the diet of dairy goats in Spain: a life cycle perspective. ***Animal Production Science***. 56(3) 646-654

14. GENERAL TEACHING EXPERIENCE

Currently I am part of the PhD programme "Doctorado en Cuaternario: Cambios Ambientales y Huella Humana" (UPV-EHU) and Doctoral Programme in Environmental Agrobiology (UPV-EHU). Since 2011 I am Honorary Lecturer for Universidad de Miguel Hernández and I lectured on modelling nutrient flows in livestock systems at UPV (Environmental Agrobiology-Master Program). I have also lectured at University of Bangor, Universidad Miguel Hernandez (Master Agroecología, Desarrollo Rural y Agroecología), water use management master and advanced courses at IAMZ-CIHEHAM (Zaragoza, Spain), Universidad Pública de Navarra (Máster en Formación del Profesorado de Secundaria), EU REUSEWASTE course. And summer schools at UPV-EHU and UPM (at Santander).

I have also been examiner in PhD theses:

- Ana Meijide (2008, UPM, Spain).
- Alberto Sanz-Cobeña (2010, UPM, Spain).
- Raimón Ripoll (2013, U. de Zaragoza, Spain).
- Arantxa Louro López, (2015, U Lugo, Spain).
- Ana Belen Rufete (2015, UMH, Spain).
- Gareth Salmon (2017, U. Edinbourgh, UK)
- Hugo Fernandez Mena (2017, U. Bordeaux, France)
- Maite Aguilar (2017, UPNa, Spain).
- Daniel Ortiz Gonzalo (2018, University of Copenhagen, Denmark)
- Ricardo Gonzalez Quintero (2020, University of Antioquia: Medellín, Colombia).

15. MENTORING AND DISSEMINATION ACTIVITIES

I have been engaged in different initiatives to foster kids and young people's professional/scientific vocations: (i) BOOKALIFE https://bookalife.org/ (currently), (ii) TinkerLab Project-Bringing together science, climate change and technology in schools (2017), (iii) Training Caravan (organized by BC3 and Basque Government).

I have been an active blogger for RED REMEDIA (>50 entries) and I was the main coordinator and of its Website, Blog, Facebook and twitter (2012-2017) (more info on Annex).

I am very interested in conceptualising and scripting video material for scientific dissemination (e.g. https://vimeo.com/128467583 , https://vimeo.com/122731234 , An animated infographic video illustrating the role of small ruminants in Europe-climate change mitigation was produced and used as part of a debate in the COP25 in Madrid https://www.youtube.com/watch?v=NbO4EEaH7YM&t=12s

Other recent examples include:

- Manzano P. and Del Prado A. 2022. Podemos renunciar a la ganadería industrial? THE CONVERSATION https://theconversation.com/podemos-renunciar-a-la-ganaderia-industrial-174677
- Del Prado A, Pardo G, Batalla I, Manzano P. 2022. "La huella ambiental de la producción lechera española en el contexto internacional" del libro "Sector lácteo en España". MONOGRAFÍA CAJAMAR.
- Xabier Díaz de Otálora, Agustín del Prado, Federico Dragoni, Fernando Estellés Barber, Barbara Amon. 2022. La sostenibilidad en las explotaciones: desarrollo de un marco de evaluación de modelos a escala de granja.MG MUNDO GANADERO, ISSN 0214-9192, Año 33, Nº. 305, 2022, págs. 38-41.
- Del Prado A, Pardo G, Batalla I, Manzano P. 2021. "El análisis del ciclo de vida en las actividades ganaderas. del libro "Sostenibilidad en la Producción Ganadera". MONOGRAFÍA CAJAMAR. https://publicacionescajamar.es/publicacionescajamar/public/pdf/series-tematicas/informes-coyuntura-monografias/monograf-43-sostenibilidad_ganadera_w.pdf
- Del Prado A. Batalla I, G Pardo 2020. Revista Alimentaria. 515 https://www.revistaalimentaria.es/vernoticia.php?volver=&noticia=reduciendo-el-efecto-de-ovejas-y-cabras-sobre-el-cambio-climatico-a-nivel-europeo&utm_campaign=avance-semanal-13082020&utm_medium=email&utm_source=acumbamail
- Batalla I, G Pardo, del Prado A. 2020 Gases de efecto invernadero y producción caprina:¿ qué debemos tener en cuenta? Tierras. Caprino, 10-17. https://www.interempresas.net/Ganadero/Articulos/302102-Gases-de-efecto-invernadero-y-produccion-caprina-que-debemos-tener-en-cuenta.html *(in Spanish)*
- García AIM, Ruiz DRY, Pérez AA, del Prado Santeodoro, A y Pardo G. 2020 Reducción de los gases efecto invernadero mediante la inclusión de subproductos agroindustriales en la dieta. Tierras. Caprino, 18-23 *(in Spanish)*
- Calvet Sanz S, Del Prado A., Rubio A, Iglesias A, Diaz C, Yáñez-Ruiz DR, Galán E, Estellés F, Pardo G, Arriaga H, Batalla I, Alvaro-Fuentes J, Almagro M, Llonch P, Roig S, Vélez-Marroquín V. 2019. Comer menos carne contra el cambio climático: una estrategia controvertida y llena de matices. https://theconversation.com/comer-menos-carne-contra-el-cambio-climatico-una-estrategia-controvertida-y-llena-de-matices-112026 *(in Spanish, the conversation https://theconversation.com/es)*

https://redremedia.wordpress.com/2019/02/25/en-que-medida-es-efectivo-reducir-el-consumo-de-carne-para-mitigar-el-cambio-climatico/ (*in Spanish*, RED REMEDIA blog https://redremedia.wordpress.com/)
https://elpais.com/elpais/2019/02/22/planeta_futuro/1550835509_043595.html (*in Spanish*, EL PAIS https://elpais.com/).

- $SIMS_{SR}$-un nuevo modelo de granja para simular el efecto del manejo, clima y genética en las emisiones y viabilidad de pequeñas explotaciones. Presentation in RED REMEDIA workshop 2019. (In Spanish, Video https://vacapinta.com/es/tv/jornadas/los-sistemas-agroforestales-como-solucion-al-cambi/3458-simssr-un-nuevo-modelo-de-granja-para-simular-el-e.html in https://vacapinta.com/es).
- Del Prado A. 2019. Sistemas ganaderos y salud del planeta. emisiones GEI. I Jornada. Gestión de explotaciones agrarias, sistemas agroalimentarios y sostenibilidad. 26/9/2019. Villaba, Navarra. https://campus.intiasa.es/pluginfile.php/2553/mod_resource/content/1/delPradoINTIAVS2.pdf (presentation)
https://www.intiasa.es/es/component/content/article/9-contenido/1283-expertos-internacionales-debaten-sobre-ganaderia-y-sostenibilidad-en-una-jornada-organizada-por-intia.html (news)
https://www.youtube.com/watch?v=guIwxVcox2U (video in Spanish)
- Del Prado A. 2019. Rumiantes y cambio climático. ¿Ángeles o demonios? GURE LURRA-sembrando Futuro 3 https://www.gipuzkoa.eus/es/web/gure-lurra-sembrando-futuro (27/11/2019) https://www.youtube.com/watch?v=GcYgRDZp-pA&t=124s (video, in Spanish)
- Del Prado A. 2020. Seminarios COOP. http://www.agro-alimentarias.coop/reportajes/ver/NDg5 La Ganadería extensiva ante el reto de la sostenibilidad. https://www.youtube.com/watch?v=vMNU7DuujHc&t=2s
https://www.youtube.com/watch?v=cEyadf0kvzE (video, in Spanish 21/07/2020).
- Del Prado A. 2020. Ganadería industrial y cambio climático. Jornadas online Amigos de la Tierra #MenosCarneMejorCarne https://www.tierra.org/agenda/jornadas-online-menoscarnemejorcarne/ https://www.youtube.com/watch?v=V9XIzif_5_8&t=2913s (video, in Spanish 19/05/2020).
- Del Prado A., et al. 2020. Jornadas online Amigos de la Tierra La ganadería y su contribución al cambio climático (presentación informe Amigos de la Tierra & BC3) #MenoscarneMejorcarne https://www.youtube.com/watch?v=B45kXIAZ2vM (video, in Spanish 16/10/2020).
- Webinar: La contribución de los documentos zootécnicos de balance alimentario a los inventarios de gases de la ganadería https://redremedia.wordpress.com/2020/05/12/webinar-la-contribucion-de-los-documentos-zootecnicos-de-balance-alimentario-a-los-inventarios-de-gases-de-la-ganaderia-21-de-mayo-a-las-10h/ https://www.youtube.com/watch?v=tU9w0asMuFc&t=5215s (21/5/2020)

16. PRIZES, MENTIONS AND DISTINCTIONS

2017. First Award for the supervision of the best PhD thesis (Guillermo Pardo Nieva) on Climate Change in the Mediterranean area of Spain. Cátedra de Cambio Climático adscrita al Instituto Universitario de Ingeniería del Agua y Medio Ambiente (IIAMA) (univesitat Polictecnica de Valencia)

2016. Best paper award 2016-European Society of Agricultural Engineers Young Engineers' (Sanchis et al., 2016). European Agricultural Engineers Type of entity: Associations and Groups, Aarhus, Denmark

2006-2007. Performance Merit award 2006 Institute of Grassland and environment Research (IGER), Aberystwyth, United Kingdom.

2006. Elected to participate in international representation (UK) to reduce agricultural GHG and to understand the impacts of climate change on terrestrial ecosystems (British Council-CSIC Spain).

Interactions between climate change and grassland-based agriculture. Workshop on 'Understanding Impacts of Climate Change on Terrestrial Ecosystems'.

ANNEX

INTERNATIONAL PEER-REVIEWED JOURNALS:

1. Garmendia E, Aldezabal A, Galan E, Andonegi A, del Prado A, Gamboa G, Garcia O, Pardo G, Aldai N and Barron LJR 2022. Mountain sheep grazing systems provide multiple ecological, socio-economic, and food quality benefits. Agronomy for Sustainable Development 42, 47.
2. Jebari A, Álvaro-Fuentes J, Pardo G, Batalla I, Martín JAR and Del Prado A 2022. Effect of dairy cattle production systems on sustaining soil organic carbon storage in grasslands of northern Spain. Regional Environmental Change 22, 67.
3. Pardo G, del Prado A, Fernández-Álvarez J, Yáñez-Ruiz DR and Belanche A 2022. Influence of precision livestock farming on the environmental performance of intensive dairy goat farms. Journal of Cleaner Production 351, 131518.
4. Tedeschi LO, Abdalla AL, Álvarez C, Anuga SW, Arango J, Beauchemin KA, Becquet P, Berndt A, Burns R, De Camillis C, Chará J, Echazarreta JM, Hassouna M, Kenny D, Mathot M, Mauricio RM, McClelland SC, Niu M, Onyango AA, Parajuli R, Pereira LGR, del Prado A, Tieri MP, Uwizeye A and Kebreab E 2022. Quantification of methane emitted by ruminants: A review of methods. Journal of Animal Science, skac197.
5. Domínguez IP, Prado A del, Mittenzwei K, Hristov J, Frank S, Tabeau A, Witzke P, Havlik P, Meijl HV, Lynch J, Stehfest E, Pardo G, Barreiro-Hurle J, Koopman J and Sánchez MJS 2021. Different appreciations of methane's global warming potential may affect the cost-effectiveness of carbon pricing and low-meat diets. Nature Food (with minor corrections at 4/09/2021).
6. Díaz de Otálora X, del Prado A, Dragoni F, Estellés F and Amon B 2021. Evaluating Three-Pillar Sustainability Modelling Approaches for Dairy Cattle Production Systems. Sustainability 13, 6332.
7. Jebari A, Álvaro-Fuentes J, Pardo G, Almagro M and Prado A del 2021. Estimating soil organic carbon changes in managed temperate moist grasslands with RothC. PLOS ONE 16, e0256219.
8. Pardo G and del Prado A 2021. A simple model for the effect of thermal stress on the productivity of small ruminants. Livestock Science 251, 104649.
9. Del Prado A del, Manzano P and Pardo G 2021. The role of the European small ruminant dairy sector in stabilising global temperatures: lessons from GWP* warming-equivalent emission metrics. Journal of Dairy Research 88, 8–15.
10. Del Prado A., Galán E, Batalla I, Pardo G. 2020. Impactos y adaptación al cambio climático en rumiantes. ITEA. Invited review. 116-5 (461-482). https://doi.org/10.12706/itea.2020.038
11. Pardo, G., del, Prado, A. 2020. Guidelines for small ruminant production systems under climate emergency in Europe. Small Ruminant Research 193, 106261. https://www.sciencedirect.com/science/article/abs/pii/S0921448820302108
12. Sampedro, J., Waldhoff, S.T., Van de Ven, D.-J., Pardo, G., Van Dingenen, R., Arto, I., del Prado, A., Sanz, M.J., 2020. Future impacts of ozone driven damages on agricultural systems. Atmospheric Environment 231, 117538. https://doi.org/10.1016/j.atmosenv.2020.117538
13. Dellar, M., Topp, C., Pardo, G., del Prado, A., Fitton, N., Holmes, D., Banos, G., Wall, E., 2019. Empirical and dynamic approaches for modelling the yield and N content of European grasslands. Environmental Modelling & Software 122, 104562. https://doi.org/10.1016/j.envsoft.2019.104562
14. Ghahramani, A., Howden, S.M., del Prado, A., Thomas, D.T., Moore, A.D., Ji, B., Ates, S., 2019. Climate Change Impact, Adaptation, and Mitigation in Temperate Grazing Systems: A Review. Sustainability 11, 7224. https://doi.org/10.3390/su11247224
15. Hempel, S., Menz, C., Pinto, S., Galán, E., Janke, D., Estellés, F., Müschner-Siemens, T., Wang, X., Heinicke, J., Zhang, G., Amon, B., Prad, A. del, Amon, T., 2019. Heat stress risk in European dairy cattle husbandry under different climate change scenarios – uncertainties and potential impacts. Earth System Dynamics 10, 859–884. https://doi.org/10.5194/esd-10-859-2019

16. Kipling, R.P., Topp, C.F.E., Bannink, A., Bartley, D.J., Blanco-Penedo, I., Cortignani, R., del Prado, A., Dono, G., Faverdin, P., Graux, A.-I., Hutchings, N.J., Lauwers, L., Özkan Gülzari, Ş., Reidsma, P., Rolinski, S., Ruiz-Ramos, M., Sandars, D.L., Sándor, R., Schönhart, M., Seddaiu, G., van Middelkoop, J., Shrestha, S., Weindl, I., Eory, V., 2019. To what extent is climate change adaptation a novel challenge for agricultural modellers? Environmental Modelling & Software 120, 104492. https://doi.org/10.1016/j.envsoft.2019.104492
17. Sanchis, E., Calvet, S., Prado, A. del, Estellés, F., 2019. A meta-analysis of environmental factor effects on ammonia emissions from dairy cattle houses. Biosystems Engineering 178, 176–183. https://doi.org/10.1016/j.biosystemseng.2018.11.017
18. Galán E., Llonch P., Villagrá A., Levit H., Pinto S. & Prado A. del (2018) A systematic review of non-productivity-related animal-based indicators of heat stress resilience in dairy cattle. PLOS ONE 13: e0206520
19. Jebari, A., del Prado, A., Pardo, G., Rodríguez Martín, J.A., Álvaro-Fuentes, J., 2018. Modeling Regional Effects of Climate Change on Soil Organic Carbon in Spain. Journal of Environment Quality 0, 0. https://doi.org/10.2134/jeq2017.07.0294.
20. Sanz-Cobena A., Lassaletta L., Aguilera E. , del Prado A. , Garnier J. , Billen G. , Iglesias A., Sánchez,B. Guardia, G. Abalos,D. Plaza-Bonilla, D., I. Puigdueta-Bartolomé, R. Moral, E. Galán, H. Arriaga, P. Merino, J. Infante-Amate, A. Meijide, G. Pardo, J. Álvaro-Fuentes, C. Gilsanz, D. Báez, J. Doltra, S. González-Ubierna, M.L. Cayuela, S. Menéndez, E. Díaz-Pinés, J. Le-Noë, M. Quemada, F. Estellés, S. Calvet, H.J.M. van Grinsven, H. Westhoek, M.J. Sanz, B.S. Gimeno, A. Vallejo, P. Smith, (2017). Strategies for greenhouse gas emissions mitigation in Mediterranean agriculture: A review, Agriculture, Ecosystems & Environment. 238: 5-24. (http://dx.doi.org/10.1016/j.agee.2016.09.038).
21. Pardo, G., del Prado, A., Martínez-Mena, M., Bustamante, M. A., Martín, J. R., Álvaro-Fuentes, J., & Moral, R. (2017). Orchard and horticulture systems in Spanish Mediterranean coastal areas: Is there a real possibility to contribute to C sequestration?. Agriculture, Ecosystems & Environment. 238: 153-167. (http://dx.doi.org/10.1016/j.agee.2016.09.034).
22. Pardo G, Moral R and del Prado A. 2017. SIMSWASTE-AD - A modelling framework for the environmental assessment of agricultural waste management strategies: Anaerobic digestion. Science of The Total Environment, 574:806–817. (http://dx.doi.org/10.1016/j.scitotenv.2016.09.096).
23. Pardo G. Martin-Garcia I., Arco A., Yañez-Ruiz D., Moral R and del Prado A. 2016. Greenhouse gas mitigation potential of including agro-industrial by-products in the diet of dairy goats in Spain: a life cycle perspective. Animal Production Science. 56(3) 646-654 (http://dx.doi.org/10.1071/AN15620).
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26. Gallejones, P. , Aizpurua A. , Ortuzar-Iragorri,M.A. and del Prado,A. 2016. Development of a new model for the simulation of N2O emissions: a case-study on wheat cropping systems under humid Mediterranean climate. Mitigation And Adaptation Strategies For Global Change. 21(7), 1107–1130 DOI (10.1007/s11027-014-9563-6).

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28. Mas, K., Pardo, G., Galán, E. and del Prado,A . 2016. Assessing dairy farm sustainability using whole-farm modelling and life cycle analysis. Advances in Animal Biosciences, 7(3), 259–260. DOI (10.1017/S2040470016000340).
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30. Pardo G, Moral R, Aguilera E, del Prado A. 2015. Gaseous emissions from management of solid waste: A systematic review. Global Change Biology. 21, 1313-1327. (DOI: 10.1111/gcb.12806).
31. Balbi, S., Del Prado, A., Gallejones, P., Geevan, C.P., Pardo, G., Pérez-Miñana, E., Manrique, R., Hernandez-Santiago, C., Villa, F., 2015. Modeling trade-offs among ecosystem services in agricultural production systems. Environmental Modelling & Software. 72: 314–326 (doi:10.1016/j.envsoft.2014.12.017).
32. Yeluripati, J.B, Del Prado, A., Rees R.M., Li, C., Chadwick, D., Tilston, E.L., Topp,C.F.E., Cardenas, L., Sanz-Cobena, A., Ingraham P., Gilhespy, S.L., Anthony, S., Vetter, S.H., Misselbrook, T., Salas, W. and Smith, P. 2015. Global Research Alliance Modelling Platform (GRAMP): An open web platform for modelling greenhouse gas emissions from agro-ecosystems. Computers and Electronics in Agriculture, 111: 112–120 (doi:10.1016/j.compag.2014.11.016).
33. Gallejones P., Pardo G., Aizpurua A., del Prado A. 2015. Life cycle assessment of first-generation biofuels using a nitrogen crop model. Science of the Total Environment.1, 1191–1201.(doi:10.1016/j.scitotenv.2014.10.061).
34. Pardo G , D Yañez-Ruiz, I Martin-Garcia, A Arco, R Moral and del Prado,A . 2015. Modelling the impact on GHG emissions of using underutilized feed resources in dairy goat systems. Advances in Animal Biosciences, 6:1, pp 38–40 (Extended Abstract).
35. Sanz-Cobena, A., Lassaletta, L., Estellés, F., Del Prado, A., Guardia, G., Abalos, D., Aguilera, E., Pardo, G., Vallejo, A., Sutton, M.A., Garnier, J., and Billen, G. 2014. Yield-scaled mitigation of ammonia emission from N fertilization: the Spanish case. Environmental research letters. 9, 125005. doi:10.1088/1748-9326/9/12/125005
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38. Del Prado A, Mas K, Pardo G., Gallejones. P. 2013. Modelling the interactions between C and N farm balances and GHG emissions from confinement dairy farms in northern Spain. Science of The Total Environment. 465, 156-165.
39. Del Prado A., Crosson P., Olesen J.E. and Rotz A. 2013. Whole-farm models to quantify greenhouse gas emissions and their potential use for linking climate change mitigation and adaptation in temperate grassland ruminant-based farming systems. Animal. 7 (suppl.2), 373-385.

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41. Misselbrook T., Del Prado A., Chadwick D. 2013. Opportunities for reducing environmental emissions from forage-based dairy farms. Agriculture and Food Science. 22: 93–107.
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43. Del Prado A., Misselbrook T, Chadwick D, Hopkins A, Dewhurst R.J., Davison P., Butler A., Schröder J., and Scholefield D. 2011. SIMSDAIRY: A modelling framework to identify sustainable dairy farms in the UK. Framework description and test for organic systems and N fertiliser optimisation. Science of the Total Environment 409 (19): 3993-4009.
44. Cardenas L.M., Cuttle S.P., Crabtree B., Hopkins A., Shepherd A. Scholefield D. and del Prado A. 2011. Cost effectiveness of nitrate leaching mitigation measures for grassland livestock systems at locations in England and Wales. Science of the Total Environment. 409 (3-4): 1104-1115.
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49. Hopkins A. and del Prado A. 2007. Implications of climate change for grassland management: impacts, adaptations and mitigation options: a review. Grass and Forage Science 62 (2): 118-126.
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Articles in rev/submitted/drafted

60. Del Prado, A, Lynch, J Liu, S. Ridouttd, B., Pardo, G. Mitloehner F. (Subm and in 2nd Rev in ANIMAL).
61. Opportunities and challenges in using GWP* to report the impact of ruminant livestock on global temperature change.
62. Diaz de Otálora X, Dragoni F , Del Prado A , Estellés F , Wilfart A, Krol D , Balaine L, Anestis V , Amon B. (Subm and in 2nd Rev in Agronomy for Sustainable Development). Identification of representative dairy cattle and fodder crop production typologies at regional scale in Europe Analysis of typologies and interactions of key integrated dairy-fodder crop production system in Europe.
63. Manzano P Pardo G, Itani, MA, del Prado A, (Submand in 2nd Rev in npj Biodiversity). Underrated past herbivore densities could lead to misoriented sustainability policies
64. Jebari A, Pardo G, Prado A del, Álvaro-Fuentes J. (Subm to Plant & Soil). Potential impacts of climate change on soil organic carbon and net GHG emissions of grasslands associated with dairy production in northern Spain.
65. Pardo G, Casas R, del Prado A, Manzano P. (Subm to Plant & Soil). Carbon footprint of transhumant sheep farms: accounting for natural baseline emissions in Mediterranean systems
66. Manzano P Pardo G, del Prado A, (to be Subm to Nature). Wildlife savannas: similar source of greenhouse gases to comparable pastoralism-dominated areas.
67. Yamat L, Manzano P, del Prado A, Sanz-Sanchez MJ. (Drafted). Post-2020 Climate Actions in the Sub-Saharan Africa: NDCs Analysis of 17 Countries
68. Zulueta R, Manzano P, del Prado A, (Drafted). Behind Regenerative Rangeland Management in Spain: prescribed guidelines are not required.

Articles in international non peer-reviewed journals

69. Ortenzi F, McAuliffe GA, Leroy F, Nordhagen S, Vliet S van, Prado A del and Beal T 2022. Uncertainties in the impact of small targeted dietary changes on human health and environmental sustainability. Preprint. SocArXiv Papers https://osf.io/preprints/socarxiv/k8ghb/

INTERNATIONAL UN REPORTS

1. Gavrilova O., Leip A., Dong H., MacDonald D.J, Gomez-Bravo C.A., Amon B., Barahona-Rosales R., Del Prado A., De Lima M. A., Oyhantcabal W., Van der Werden T and Widiawati Y. 2019. Emissions from livestock and manure management. 2019 Refinement to the 2006 IPCC Guidelines

for National Greenhouse gas Inventories. IPCC Intergovernmental Panel on Climate Change, Geneva, pp. 10.1–10.225. https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch10_Livestock.pdf
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OTHER REPORTS (PEER REVIEWED)

1. Batalla et al. In prod. Medidas tecnológicas y prácticas de mitigación de emisiones en vacuno de leche y carne en España. MITECO, OECC, Spanish Dept. Agriculture.
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3. Del Prado A., Baucells J. Casasús I. and Fondevila M. 2019. Bovino: Bases zootécnicas para el cálculo del balance alimentario de nitrógeno y de fósforo. Publisher: Ministerio de Agricultura, Pesca y Alimentación. MAdrid, 906 págs. ISBN: NIPO: 003-19-237-4 (papel) NIPO: 003-19238-X (línea) Depósito Legal: M-37409-2019 https://bit.ly/2B3ADtd
4. Del Prado A, Batalla I, Pardo G, Galán E, Thomas C, Ragkos A, Theodoridis A and Arsenos G 2020 Deliverable 4.4 Project EU ISAGE. New trajectories towards innovative sheep and goat production systems.
5. Vouraki S, del Prado A, Theodoridis A, Arsenos G 2020. Project EU ISAGE. Deliverable 4.6. Decision support tools to help farmers make informed decisions about how to reduce environmental impacts, improve animal welfare and increase profitability
6. Del Prado A, Batalla I, Pardo G, Jebari A, Ragkos A, Alexandros T and Arsenos G 2019 Deliverable 4.3. Project EU ISAGE. New holistic model that can be used to redesign terrestrial small ruminant's livestock systems. https://www.isage.eu/wp-content/uploads/D4.3_Holistic-farm-model.pdf
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9. Mullender, S.; Zaralis, K.; Pardo, G.; Del Prado, A.; Dellar, M.; Yañez-Ruiz, D.; Carabaño, MJ.2017. Review of information on FP7 projects and literature on climate change and small ruminants (deliverable 3.1). ISAGE H2020 Report. 2017. Available on-line at: http://www.isage.eu/wp-content/uploads/D3.1_climate_review.pdf .

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40. Del Prado Agustin, Alvaro-Fuentes Jorge, Arriaga Haritz, Báez Dolores, Bernal Maria Pilar, Cantero Carlos, Estellés Fernando, Merino Pilar, Moral Raúl, Pardo Guillermo, Salcedo Gregorio, Calvet Salvador, Sanz-Cobeña Alberto. 2013. GHG emissions associated with manure management from livestock systems in a Mediterranean country. A case study: Spain. . INRA - Université de Versailles St-Quentin-en-Yvellines, Versailles.
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42. Pardo, G., del Prado, A.,Moral, R., Agulló, E., , Paredes, C., Bustamante, M.A., Perez-Murcia M.D., Perez-Espinosa, A., Garcia-Martinez, S., Ruiz, J.J. 2013. Compost from winery wastes as perlite substitutes in growing media for tomato intensive production. Implications in terms of greenhouse gas emissions. Campus de Aula Dei - Zaragoza.
43. Pardo, G.,Moral, R., del Prado, A. 2013. Evaluación comparativa de las emisiones asociadas a alternativas para el tratamiento y valorización de residuos agrícolas mediante análisis de ciclo de vida. Campus de Aula Dei - Zaragoza.
44. Gallejones P., Aizpurua A. and Del Prado, A. 2012. Modelling the effect of N management on N losses, net energy balance and plant quality in a wheat-rapeseed rotation. 17th N Workshop, Dublin (Ireland). 337-338. Poster: Gallejones P.
45. Del Prado, A. Misselbrook T. Chadwick, D.R. Newbold C. J. 2011. Nitrogen co-benefits and trade-offs of novel CH4 mitigation measures applied on livestock systems. Nitrogen and Global Change: Key Findings – Future Challenges. Oral presentation: del Prado A.
46. Del Prado, A., A. Shepherd, L. Wu, C. Topp, D. Moran, B. Tolkamp, Gallejones P. and Chadwick D. 2011. Modelling the effect of climate change only on environmental pollution losses from UK dairy

systems. Nitrogen and Global Change: Key Findings – Future Challenges. Oral presentation: del Prado A.
47. Prado, A. 2011. System-based mitigation strategies to reduce GHG within and between multifunctional land-use elements of a landscape. The James Hutton Institute (8th April, 2011).
48. Del Prado A., Martin-Ortega J., Misselbrook T, Chadwick D., Pardo G, del Hierro O., Moral R. 2010. Desarrollo De Una Herramienta de simulación sistémica para evaluar el uso más eficiente de los residuos provenientes de la ganadería. II Jornadas de la Red Española de Compostaje "Compostaje De Residuos Orgánicos Y Seguridad Medioambiental". Burgos-Palencia 1-3 Junio 2010. Oral presentation: del Prado A.
49. Del Prado A. 2010. The effect of intensive livestock production on air, soil and water. Workshop: Soil property dynamics under different land uses and management (Dinámica de las propiedades del suelo bajo diferentes usos y manejos), INIA-Uruguay (Uruguay). Keynote speaker: del Prado A.
50. Pilgrim E, Macleod C.J.A., Beaumont D.,. Blackwell M.S.A, Bol R, Del Prado A.,. Griffith B, Orr R., Shepherd A., Wu L., and Firbank L G. 2010. Learning how to model ecosystem trade-offs at the farm scale. International Environmental Modelling and Software Society (iEMSs). 2010 International Congress on Environmental Modelling and Software. Modelling for Environment's Sake, Fifth Biennial Meeting, Ottawa, Canada. David A. Swayne, Wanhong Yang, A. A. Voinov, A. Rizzoli, T. Filatova (Eds.) http://www.iemss.org/iemss2010/index.php?n=Main.Proceedings
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53. Del Prado A. Systems Modelling For Sustainable Farming. Seminario CSIC. Estación Experimental del Zaidín, Granada. Keynote speaker: del Prado A.
54. Dragosits U., Chadwick D.R., del Prado A., Scholefield D., Mills J.A.N., Crompton L.A. and Newbold C.J. 2008. Implications of farm-scale methane mitigation measures for UK methane emission. Proceedings of the SAC and SEPA Biennial Conference, Edinburgh, 26-27 March 2008. ISBN 1 85482 867 3. p.168-174. Cited by in Scopus: 1.
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56. Cárdenas L.M., Scholefield D., Cuttle S., Crabtree B., Hopkins A. and del Prado A. Nitrate Cost Curve of Mitigation Options for Grassland Soils in the UK. 15th N Workshop, Lleida (Spain).
57. Del Prado and Scholefield D. Use of SIMSDAIRY modelling framework system to specify sustainable UK dairy farms. Aspects of Applied Biology 80, 2006. Delivering sustainability within profitable farming systems – is it possible? Oral presentation: del Prado A.
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59. Del Prado A. Interactions between climate change and grassland-based agriculture. Workshop on 'Understanding Impacts of Climate Change on Terrestrial Ecosystems'. British Council & CSIC Spain. Carmona (Sevilla), Spain, 27 February-2 March 2006. Oral presentation: del Prado A.
60. Del Prado A. and Scholefield D. Use of SIMSDAIRY modelling framework system to specify sustainable UK dairy farms. Delivering Sustainability within profitable faming systems- is it possible? Oral presentation: del Prado A.

61. Del Prado, A., Cardenas, L., Scholefield, D., 2005. Impact of NO3 leaching abatement measures on N2O and CH4 emissions from a UK dairy system. Working Papers, Second International Conference on Greenhouse Gases and Animal Agriculture (GGAA), 20-24 September 2005, Zurich, Switzerland, 218-221. Cited by in Scopus: 1.
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64. Jewkes E.C., del Prado A. and Scholefield D. Meeting the Challenge: two approaches to improving nutrient use efficiency in dairy agriculture. Poster presentation to the International Fertiliser Society conference, 14-16 December 2005, Cambridge UK
65. Del Hierro O., Pinto M., Artetxe A. and del Prado A. Nitrogen concentrations in an intensively farmed livestock catchment.'Controlling N Flows and Losses'. Proceedings 12th Nitrogen Workshop, University of Exeter, 21-24 September 2003. In: Hatch D.J., Chadwick D., Jarvis S.C. and Roker J.A., eds. 420-422. Wageningen Academic Publishers.
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67. del Prado, A., Brown, L., Scholefield, D., 2004. NGAUGE DSS as a tool to assist UK dairy farmers to comply with EU nitrate legislation. Controlling Nitrogen Flows and Losses, 423-424. Cited by in Scopus: 1.
68. Brown, L., Scholefield, D., Jewkes, E.C., Del Prado, A., Lockyer, D.R., 2004. NGAUGE: A decision support system to optimize N fertilization of UK grassland for economic and/or environmental goals. Controlling N Flows and Losses, 565-566. Cited by in Scopus: 2.
69. Del Hierro, O., Pinto, M., Artetxe, A., del Prado, A., 2004. Nitrogen concentrations in an intensively farmed livestock catchment. Controlling Nitrogen Flows and Losses, 420-422.
70. Merino P., del Prado A., Menéndez S., Careaga L., Pinto M., Estavillo J.M. and González-Murua C. 2003. Reducing losses of Nitrous oxide from cattle slurry and mineral fertiliser applied to grassland by the use of DMPP. 12th N Workshop, Exeter, UK.
71. Scholefield D., Brown L. and del Prado A. Modelling catchments to predict the impact on production and the environment for grassland agriculture.'Adapting to farming within an NVZ - science into practice'. Abstracts, BSSS meeting, SCI Headquarters, London, UK.
72. Del Hierro O., del Prado A., Artetxe A. and Pinto M. Water quality impacts associated with an intensive farm in the North of Spain (Basque Country). Watershed Management to Meet Emerging TMDL Conference. Texas, USA.
73. Del Prado A., Del Hierro O., Artetxe A. and Pinto M. 2002. Nitrogen economy and environmental sustainability in an intensively managed dairy farm in the Basque Country. 19th General Meeting of the European Grassland Federation. La Rochelle, France.

74. Del Prado A., Pinto M., Corré W., Merino P. 2000. Estimates of N2O emissions from soil in commercial farms in the Basque Country dairy farms. 5: 484-489. 18th General Meeting of the European Grassland Federation. Denmark.
75. Del Prado A., Corre W.J. and Oenema O. 1999. Modeling gaseous nitrogen oxide losses from livestock farming systems in Europe. Vol 2, II-10. 10th N Workshop, Copenhagen, Denmark.
76. Del Prado, A., Merino, P., Pinto, M., Estavillo, J.M. Ensayo de Invernadero sobre los efectos de la fuente de N, el agua y la tª sobre las pérdidas de N en forma de óxidos de N. Vol 20. 2nd Iberic congress on Environmental Pollution and Toxicology. Leioa, Spain.

R&D PROJECTS FUNDED THROUGH COMPETITIVE CALLS OF PUBLIC OR PRIVATE ENTITIES

Principal Investigator/Coordinator

2017-2021. Gestión de deyecciones en sistemas productivos de vacuno de leche de la cornisa cantábrica. de la explotación al territorio: eficiencia del uso de nutrientes, mitigación de gases de efecto invernadero y reducción de la huella de carbono (PI-BC3). Funded by MINECO RTA2015-00058-C06-05 **(PI)**

2013-2015. Modelling gaseous N and C emissions using DNDC in order to obtain emission factors under different agricultural practices (**PI**). Convocatoria Plan Nacional de investigación fundamental no-orientada. [€16000]. AGL2012-37815-C05-04 **(PI)**

2013-2014. ENERKROP: Desarrollo y aplicación de modelos agronómicos para la evaluación ambiental y energética de la producción de biocombustibles en la CAPV. Programa SAIOTEK (Industria, Innovación, Comercio y Turismo; Gobierno Vasco) ((Coordinator, **PI**). [€50000].

2010-2012. LAND_GHG. Desarrollo de estrategias de mitigacion con enfoque de sistema para reduccion de gases invernadero dentro y entre elementos multifuncionales de un paisaje. Convocatoria Plan Nacional de investigación fundamental no-orientada. (Coordinator, **PI**). [€61,710]. CGL2009-10176 http://www.land-ghg.net

2010-2012. ECOAGRIWASTE. Desarrollo de un marco de modelización con aproximación sistémica para evaluar el uso más eficiente de los desechos provenientes de la industria agroalimentaria para mitigación de emisiones de GEI con mínimos o positivos impactos en los servicios y bienes de los ecosistemas agrarios. Modalidad 2: Proyectos En Cooperación. Departamento De Educación, Universidades e Investigación Del Gobierno Vasco. (Coordinator, **PI**). [€5400 (BC3) +€5900+€5900]. PC2010-33A

2004-2007. New integrated dairy production systems: specification, practical feasibility and ways of implementation (IS0214). Department for Environment, Food and Rural Affairs (DEFRA) [£446,603]. **(PI)**.

2002-2004. Developing the simulation N fluxes model. NCYCLE for Ireland. Environmental Protection Agency (EPA), Ireland. **(PI)**.

2014. Fundación Biodiversidad. "Mitigando ConCiencia y Alimentación: Programa de Actividades para la Divulgación de la Ciencia del Cambio Climático en el Sector Agroalimentario Español". [€35784]. https://fundacion-biodiversidad.es/sites/default/files/multimedia/archivos/resolucion_final_conv._ano_2014.pdf (Awarded/Funded through RED REMEDIA but not implemented because of burocratic financing matters) (**coordinator**)

Theme, Wp Leader/Other

2021-2023. CircAgric project. MICINN (MINECO) - MINISTERIO DE CIENCIA E INNOVACION. 2021-2023. 2021 JOINT CALL ERA-NET Cofund SusAn, FACCE ERA-GAS, ICT-AGRI-FOOD and SusCrop

2016-2020. ISAGE. Innovation for Sustainable Sheep and Goat Production in Europe. EU H2020 SFS-01c-2015 - Assessing sustainability of terrestrial livestock production (**WP3 leader**) Funded by EU (H2020).

2013. Defra-GRAMP GRA Modelling Platform Project: Review of Available Resources and Experimental Databases for modelling N2O emissions from agricultural systems. Part of a large UK project coordinated by Prof P. Smith (Aberdeen U.). Department for Environment, Food and Rural Affairs (DEFRA)

2012-2019. Optimising the efficiency of dietary nitrogen use to reduce emissions and waste in dairy systems - AC0122. Department for Environment, Food and Rural Affairs (DEFRA) [£3,472,896].

2012-2015. FACCE-MACSUR Knowledge Hub. FACCE JPI pilot action: 'Modelling European Agriculture with Climate Change for Food Security (MACSUR)'. [15M€]. **Theme Leader** (in Livestock Subtheme).

2007-2011. Institute Strategic Programme Grant 5. Grassland Environment and Soil System. Biotechnology and Biological Sciences Research Council (BBSRC, UK). **Theme Leader** Developing a systems-based modelling approach to understanding and predicting consequences of grassland soil managements for atmosphere and water environments. [£3,215,343].

2008-2009. Structuring Infrastructures for the Analysis and Experimentation on Ecosystems (ANAEE). Seventh Research Framework Programme (FP7). [1079338€]. **Work Package Leader**.

2006-2009. Cost curves for multiple diffuse pollutants. : Department for Environment, Food and Rural Affairs (DEFRA) [£1,145,934]. **Work Package Leader**.

Institute PI/Other roles

2007-2012. Understanding the behaviour of livestock manure multiple pollutants through contrasting cracking clay soils (WQ0118). Department for Environment, Food and Rural Affairs (DEFRA) [£3,999,703].

2007-2011. Institute Strategic Programme Grant 6. Delivering multifunctional Landscapes. Characterising sustainable, adaptive land management systems. Biotechnology and Biological Sciences Research Council (BBSRC).

2007-2010. Development of an integrated management framework and approaches for livestock farming systems (IF0124). Department for Environment, Food and Rural Affairs (DEFRA). [£300,000].

2007-2010. Ruminant nutrition regimes to reduce methane and nitrogen emissions (AC0209). Department for Environment, Food and Rural Affairs (DEFRA) [£746,495].

2007-2010. Future patterns of ammonia emissions across the UK and the potential impact of local emission reduction measures (AC0109). Department for Environment, Food and Rural Affairs (DEFRA) [£205,370].

2007-2009. Climate change impacts on the livestock sector (AC0307). Department for Environment, Food and Rural Affairs (DEFRA) [£199,661].

2006-2010. The optimisation and impacts of expanding biogas production in the UK (AC0406). Department for Environment, Food and Rural Affairs (DEFRA) [£306,759].

2006-2007. Forage brassicas for out-wintering stock. Department for Environment, Food and Rural Affairs (DEFRA) [£15,395].

2004-2005. Implications of farm-scale methane mitigation measures for long-term national methane emissions (CC0270). Department for Environment, Food and Rural Affairs (DEFRA) [£59,826].

2004-2004. Quantification and validation of the total N2O budget in UK forests. Natural Environment Research Council (NERC).

2003-2006. Blue prints for sustainable nutrient use in grassland livestock production (IS0101). Department for Environment, Food and Rural Affairs (DEFRA) [£297,451].

2002-2005. Nitrogen flows on farms for extended grazing (NT2509). Department for Environment, Food and Rural Affairs (DEFRA) [£300,955].

2002-2005. Dairy farm dirty water - seeking the best solutions to avoid pollution (LK0650). Department for Environment, Food and Rural Affairs (DEFRA). [£192,850].

2003-2004. Cost Curve of Nitrate Mitigation Options (NT2511). Department for Environment, Food and Rural Affairs (DEFRA) [£95,485].

2003-2003. Novel laboratory and field techniques to improve understanding of the denitrification process and enable the development of a new model. Biotechnology and Biological Sciences Research Council (BBSRC).

2001-2003. Development of indicators for nutrient management of dairy farms (NT1854). Department for Environment, Food and Rural Affairs (DEFRA) [£70,500].

200-2004. Landscape analysis of the transport, transformation and fate of reactive nitrogen and abatement strategies (LANAS) (NER/T/S/1999/00123).

2014. Simulación del efecto que las condiciones climáticas y de manejo tienen sobre las principales interacciones entre la huella de carbono y la sostenibilidad en la producción de leche en explotaciones de vacuno lechero de Bizkaia (PI: LORRA , Ayudas a la Investigación, Desarrollo e Innovación del Sector Agrario, Alimentario y Pesquero del Gobierno Vasco, 2014).

2010-2012. AGRISOST. Sistemas agrarios sostenibles. Producción de biomasa y manejo de C, N y agua. Convocatoria: Convocatoria de Programas de I+D en tecnologías/2009. Consejería de Educación de la Comunidad de Madrid. [€6,000]. P2009/AGR-1630.

2007-2009. Study of the contribution of agroforestry systems of the north of Spain to N2O emissions. Management guidelines design. Instituto Nacional de Investigacion agraria (INIA-España). Spain.

2001-2003. Minimización del Riesgo Ambiental mediante la utilización de Cultivos Cobertera e Inhibidores de la Nitrificación en Residuos Ganaderos. Problemática de la Tolerancia al Amonio en las Plantas. MCyT nº AGL2000-0543.

2001-2002. Elaboración de índices medioambientales del N y del P para determinar su riesgo de exportación hacia los recursos hídricos en una zona de intensa actividad ganadera. Departamento Vasco de Agricultura, Pesca y Alimentación.

2000-2001. Estudio de los posibles efectos contaminantes en los recursos hídricos y en la atmósfera en una zona de intensa actividad ganadera en la cuenca de Santa Engracia. Departamento Vasco de Agricultura, Pesca y Alimentación.

1996-1999. Evaluación de las pérdidas y transformación de N en los sistemas forrajeros. CICYT AGF96-1133.

R&D NON-COMPETITIVE CONTRACTS, AGREEMENTS OR PROJECTS WITH PUBLIC OR PRIVATE ENTITIES

2021-2021. Global Dairy Platform: GWP*/GWP-we evaluation for cattle and buffalo's methane emissions: **[Total, BC3:** €20249**] (PI)**

2020-2021. CAPSA (private funding). Project on assessing the C and water footprint of dairy cattle. **[Total, BC3:** 16000€.**]**

2020-2021. CAPSA (private funding). Project on assessing the potential of feed additives to mitigate climate change in dairy cattle farming. **[Total, BC3:** 5616 €**] (PI)**

2020-2023. MILKKEY. Decision support system for sustainable and GHG optimised milk production in key European area. EU Eranet. Reference Number: 39288. I am involved as co-supervisor of PhD student and scientific advisor.

2020-Amigos de la Tierra (Friends of the Earth-Spain). La ganadería y su contribución al cambio climático. **[Total, BC3:** 1500 €**]**

2017-Amigos de la Tierra (Friends of the Earth-Spain). La Contribución de la ganadería a las emisiones de Gases de Efecto Invernadero en el Estado Español (subcontracted by Amigos de la Tierra) **[Total, BC3:** 1000 €**]**

2016-2021. SARIC- diverse forage mixtures. Biotechnology and Biological Sciences Research Council (BBSRC). subcontracted by Rothamstead Rs. (UK) http://www.reading.ac.uk/apd/research/apd-resfpgdfp.aspx

2015. S5802 GHG Platform – Nitrous Oxide Emissions Factors AC0116.
Department for Environment, Food and Rural Affairs (DEFRA) subcontracted by Rothamstead Rs. (UK) Role of A. del Prado: BC3 PI. [£15,000, aprox. €21,000].

2012-2019. Optimising the efficiency of dietary nitrogen use to reduce emissions and waste in dairy systems - AC0122. Department for Environment, Food and Rural Affairs (DEFRA) [£3,472,896].

2013. Defra-GRAMP GRA Modelling Platform Project: Review of Available Resources and Experimental Databases for modelling N2O emissions from agricultural systems. Part of a large UK project coordinated by Prof P. Smith (Aberdeen U.). Small subcontracted work (aprox 6K €) Agus (BC3-PI)

2004-2005. Development of a case to justify a higher application limit of organic manures to grassland systems, or mixed grassland/arable systems, than the 170 kg N/ha limit set by Annex III of the Nitrates Directive. Department for Environment, Food and Rural Affairs (comisioned by DEFRA).

2002-2004. Developing the simulation N fluxes model. NCYCLE for Ireland. Environmental Protection Agency (EPA), Irlanda. (PI). (comisioned by EPA-Ireland). **(PI)**

2002-2004. Evaluation of the NGAUGE DSS in the provision of guidelines for sustainable N management by livestock farmers in NVZs. (NT2506). Department for Environment, Food and Rural Affairs (DEFRA) [£52,641]. (comisioned by DEFRA).

DEVELOPMENT OF MATHEMATICAL MODELS (FULL LIST WITH DETAILS)

-A whole-farm model in order to assess sustainability trajectories from small ruminant production systems in Europe

Sustainable and Integrated Management Systems for Small Ruminants production systems (SIMS$_{SR}$) is a new model to study small ruminants' sustainability. Its development is inspired on the existing modelling framework for dairy cattle systems (SIMS$_{DAIRY}$: Del Prado et al., 2011, DEFRA, 2009). SIMS$_{SR}$ simulates the interactions between flock and land management and characteristics, climate and genetic traits (both from animals and plants) and their effect on:

- Farm environmental performance (losses of N and C in the soil-plant-animal system of a sheep/goat farming system).
- Basic economics.
- Qualitative attributes of sustainability (biodiversity, landscape aesthetics, food quality for human health and product saleability, soil quality and animal welfare).

SIMS$_{SR}$ main objective is to be able to simulate current and future farming scenarios for sustainability assessment.

The diagram illustration the main calculation is shown below.

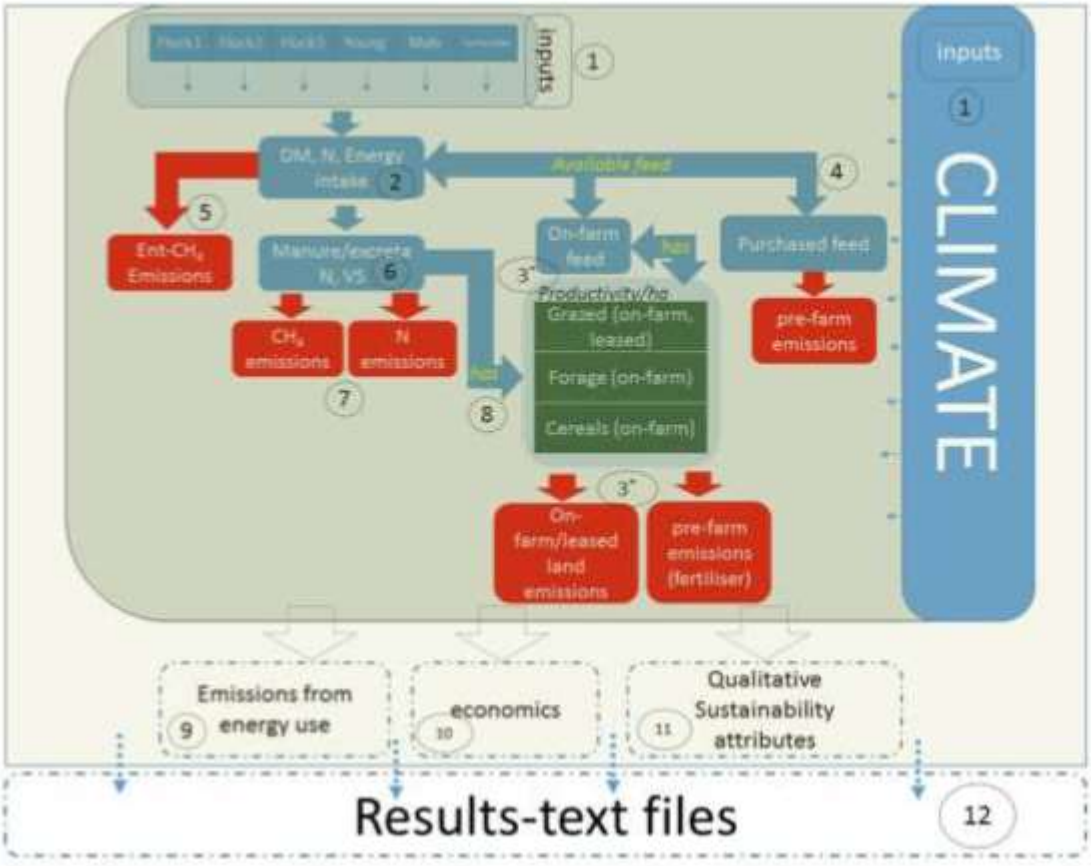

Figure 1. Diagram illustrating the main calculations in SIMS$_{SR}$

$SIMS_{NIC}$- A new simple cropping model for predicting GHG and N losses from wheat and rapeseed cropping systems.

In order to predict GHG losses and potential energy use from cropping systems a new simple cropping model was developed and calibrated for wheat and rapeseed cropping systems. This work was part of PhD thesis that Agustin supervised (Gallejones, 2014) and was partly based on experimental work carried out in the Basque Country (published in the peer review journal ***Nutrient Cycling In Agroecosystems***) (Gallejones et al. (2012). The description was published in the peer-review journal ***Mitigation And Adaptation Strategies For Global Change*** (Gallejones et al. (2016).

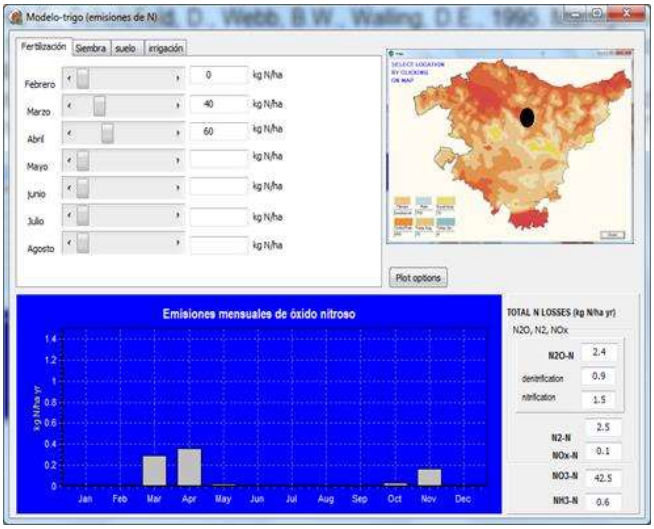

Fig 3. Example of $SIMS_{NIC}$ output user interface.

As an application $SIMS_{NIC}$ was used coupled with an LCA approach and a Monte-Carlo simulation in order to assess the sustainability of growing 2 types of energy crops (wheat and rapeseed for bioethanol and biodiesel, respectively) in the Alava province (Basque Country). This study was also part of Patricia´s PhD and was published in the high impact factor peer-review journal ***Science of the Total Environment*** (Gallejones et al., 2015).

Project: The work was carried out within the Regional Basque Project ENERKROP-Development and application of agronomic models in order to evaluate environmental sustainability of bioenergy cropping Systems in the Basque Country. Agustin was the coordinator of this project.

$SIMS_{WASTE}$- A modelling framework for assessing GHG emissions from treatment of livestock manure and other organic waste (bio-digestion and composting)

A modelling framework for treatment of livestock manure and other organic waste was developed as part of the previously mentioned projects and within the Agustin's supervised successful PhD of Guillermo Pardo (Pardo, 2006). This PhD thesis has been recently awarded as the best thesis for Climate Change studies in the Spanish Mediterranean area.

A tool has been programmed originally in Visual Basic (VB) and is proposed to link different sub-models involved in the farm system following a mass balance principle of the considered substances (C, N, P, K). In order to reflect the interactions between the activities and services of the system under study, together with the associated externalities involved, a life cycle assessment (LCA) methodology is applied at every stage, accounting for impacts related to fuel and energy production as well as potential benefits, such as biogas production and compost or digestate application.

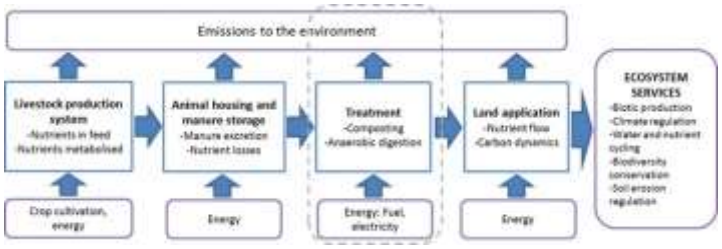

Fig 4. Modelling framework for $SIMS_{WASTE}$

Three main scenarios are considered to build the waste treatment sub-model. Anaerobic digestion (AD) and composting were selected as the most probable treatment options for livestock manure together with additional amounts of organic wastes, whereas storage of untreated slurry or solid manure previously to application on the field was considered as the conventional management scenario. The model is able to simulate different conditions for AD and type of composting treatments and their effect on net GHG and NH_3 losses, together with prediction of the final composition of the soil amendment (i. e compost or digestate).

To develop these models, first a global meta-analysis for emissions of GHG and NH_3 on solid waste was carried out and published in the high impact journal ***Global Change Biology*** (Pardo et al., 2015a). The description of the model for anaerobic digestion $SIMS_{WASTE\text{-}AD}$ was published in the high impact factor peer-review journal ***Science of the Total Environment*** (Pardo et al. 2017a). The description of the model for composting $SIMS_{WASTE\text{-}CO}$ has been published as a chapter of Pardo´s PhD thesis (Pardo, 2006) and is currently under elaboration to be submitted to a journal.

The conceptual model of the $SIMS_{WASTE}$ and its connection with its focus on ecosystem services analysis has been defended in international conferences (Pardo et al., 2013a in RAMIRAN conference) and national meetings (Del Prado et al., 2010b; Pardo et al., 2013bc).

$SIMS_{WASTE}$ has also been used for different applications. Del Prado et al (2013c), in the RAMIRAN conference, using some of the experimental work on the topic available in Spain and through the manure RED REMEDIA group that comprises some of the most relevant researchers on manure management in Spain, assessed the GHG emissions associated with manure management from livestock systems in a Mediterranean country.

Other important application was published in the high impact journal ***Agriculture, Ecosystems & Environment*** by Pardo et al. (2017b). In this study coupling the $SIMS_{WASTE}$ models with the RothC soil carbon model it was assessed, amongst other things, the potential net climate change mitigation of introducing composting or anaerobic digestion strategies in Spain.

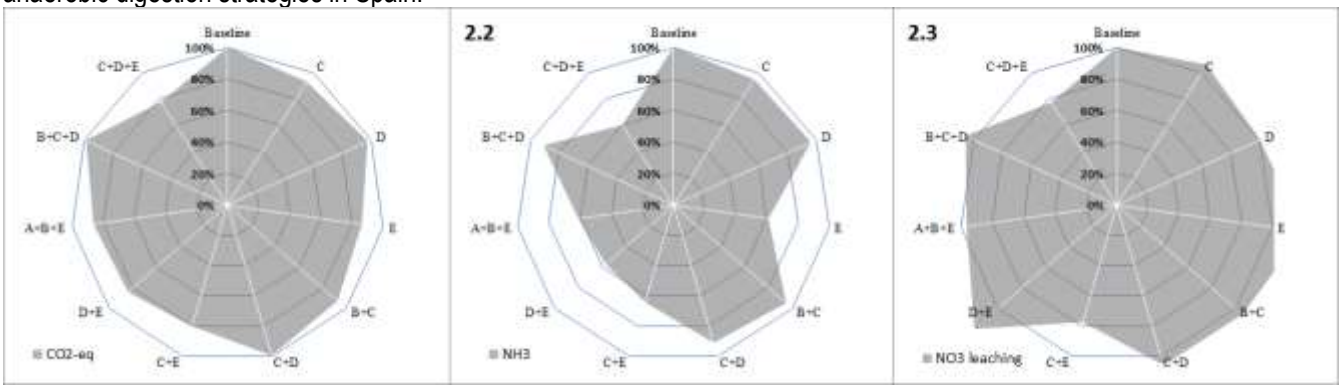

Fig 5. Comparison between simulated baseline farm and selected combinations of manure mitigation scenarios for GHG emissions (1), NH_3 (2) and NO_3 leaching (3) (Del Prado et al., 2013c)

ROTHC version for Atlantic grasslands

We have modified the RothC model in order to incorporate the grazing activity and manure amendments. Pasture yield responses and SOC accumulation may also be altered by poaching and compaction by the animals. This effect has been introduced in the RothC model. Soil compaction and yield decline may occur in seasons such as moist summer or autumn periods, particularly in temperate climates.

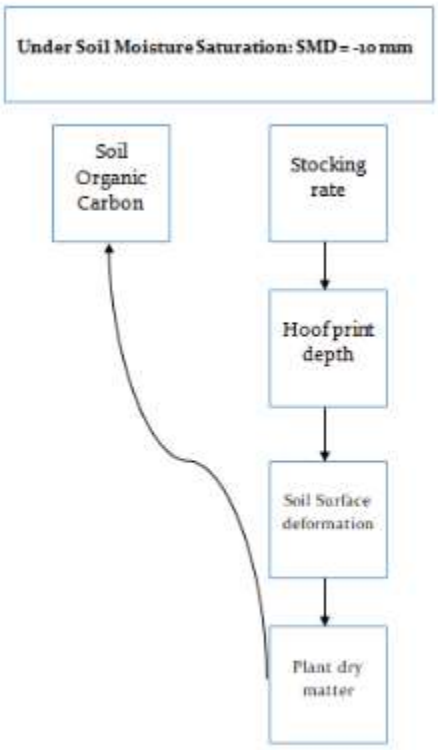

Figure 35. Model of poaching effect on SOC sequestration

Four modifications were proposed and tested in this study: (i) extensions of soil water content function up to saturation; (ii) enlargement of C input pools to account for the diversity of applied exogenous organic matter (EOM) from ruminant excreta; (iii) affinition of plant residue components and quality variability; and (iv) the trampling/poaching effect of grazing animals.

This study adapted the RothC model to managed grasslands under temperate moist conditions. The proposed modifications to the model considered the incorporation of distinction for plant residues components (i.e., above- and below-ground residues and rhizodeposition) in terms of quantity and quality and distinction for ruminant excreta quality, the extension of soil moisture up to saturation conditions and, finally, the introduction of the livestock damaging effect (i.e., poaching) on plant residues under water saturation conditions. The moisture response modification and the partition of C inputs derived from plant residues components improved the model predictability, but plant residues and ruminant excreta quality modifications improved the model predictability at a lesser extent. However, the effect of the poaching modification was minimal complicated, uncertain and of minor importance to be included in a standard modified RothC version.

The suggested modifications presented a simplification of the reality, as all mechanisms underlying the science behind SOC stock changes are complex. These modifications do not impair the performance of the model under temperate conditions and so represent a broadening in the capability of the RothC

model to be more adapted to managed grassland under temperate moist conditions. It must be kept in mind that although there was good agreement between results from modified model and measured data from different studies, validating against more sites would greatly improve our confidence.

LANDGHG

The idea was to **develop a modelling framework at the landscape scale in order to analyze strategies that help reducing the overall GHG emissions of agricultural and livestock systems**. The framework coupled emissions and flows of nutrients from different activities within a rural landscape that potentially can exchange matter and energy (livestock, waste management, cropping, agroindustry…). For this, simplifications from existing models (e.g. $SIMS_{DAIRY}$, NGAUGE) and new developments of models were designed (for composting, anaerobic digestion, cropping…).

Work was carried out and led under the umbrella of projects that Agustin was coordinator:

- Spanish National R+D+i Plan (CGL2009-10176- LANDGHG Developing system-based mitigation strategies to reduce GHG within and between multifunctional land-use elements of a landscape)
- PC2010-33A- ECOAGRIWASTE. Development of a modelling framework to evaluate the most efficient use of agro-food industrial waste in the context of GHG emission mitigation). Basque Country.

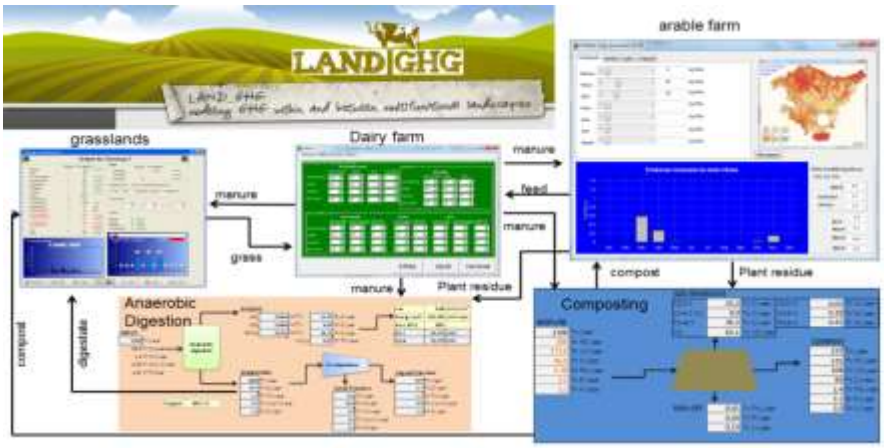

Fig 2. Schematic diagram with the main flows of matter and energy of the LANDGHG modelling approach

The general framework has been presented in different meetings; for example in 2011 in an invited talk at the The James Hutton Institute (UK) or at the III REMEDIA Workshop (Del Prado et al., 2014a).
From this approach 2 different models ($SIMS_{NIC}$ and $SIMS_{WASTE}$) and a new dairy farm model linking farm flows and LCA analysis were developed. The details of each model in isolation and when they were used coupled are explained in some of the following sections ($SIMS_{NIC}$, $SIMS_{WASTE}$, New dairy farm model+ LCA).

ECOSYSTEM SERVICES-BASED MODELLING

A line of research has been in relation to development of tools that improve our understanding of the effect of climate change (in combination by land use change) on the likely impacts on agroecosystems services and goods. The most typically studied impacts include changes in crop production and levels of biodiversity for agricultural and natural ecosystems, respectively. However, it is becoming increasingly important to study the effect of climate change on many other services provided by ecosystems (e.g. water quality and quantity, energy, air quality, soil quality, C sequestration, recycling of nutrients, genetic resources, pollination, disease regulation…) and moreover, to do so in an integrative way, not in isolation, as complex interactions among the

components of the ecosystems generally occur. Some of the aforementioned models involve some of these principles.

During this period and specifically Agustin got involved in the development of a tool to assess ecosystem services in agricultural systems. This study was published in the high impact Journal **Environmental Modelling & Software** (Balbi et al. 2015) in collaboration with different scientists at the BC3 working on artificial intelligence and using Bayesian principles. For grassland-based livestock systems Agustin participated in the review of the state-of-the-art published by Pilgrim et al. (2010) and that involved many scientists from the Rothamsted Research institute (UK).

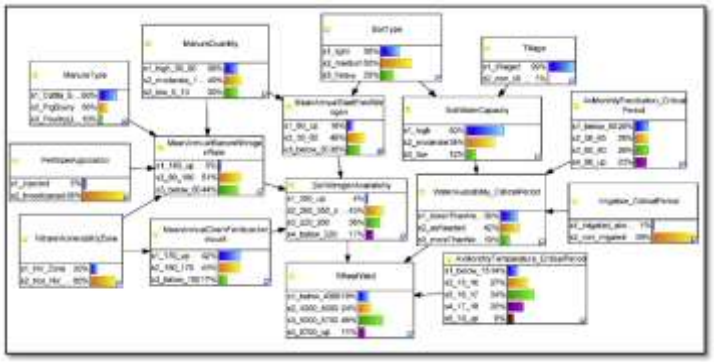

Fig 8. Bayesian diagram for the winter wheat yield modelling (Balbi et al. 2015).

REGIONAL MODELLING

Modelling at the regional level has become increasingly relevant in order to understand the environmental policy implications of different strategies applied at the national or supranational level. Examples (some already mentioned) illustrate the potential of this type of modelling:

- Studying the potential net climate change mitigation of introducing measures to increase soil organic carbon in Spanish agriculture published in ***Agriculture, Ecosystems & Environment*** by Pardo et al. (2017b).
- Assessment of potential NH_3 emissions abatement measures in Spain Sanz-Cobeña et al. (2014) published in high impact journal ***Environmental research letters*** and highlighted by the ***European Science for Environment Policy*** (Sanz-Cobeña et al., 2015). This was carried out through collaboration in the RED REMEDIA network.
- Assessment at national level of potential measures to reduce CH_4 emissions from UK farming systems (DEFRA-CC0270).
- Assessment at national level of potential measures to reduce N in the diet from UK farming systems (DEFRA- AC0122).
- Assessment at national level of potential manure management measures to reduce emissions from Spanish Dairy farming systems (INIA project: manure management GHG and NH_3 effects in dairy systems)
- Studying the potential net climate change mitigation of introducing measures to increase soil organic carbon in the Aragon region in Spain under future projections of climate change. (Asma Jebari PhD Thesis and Jebari *et al.,* in rev. in ***Journal of Environmental Quality***).

$SIMS_{DAIRY}$

This is the best example of this systems modelling approach in this period. $SIMS_{DAIRY}$ is an innovative modelling tool to study farm sustainability. Agustin was the main PI of the DEFRA project (New integrated dairy production

systems: specification, practical feasibility and ways of implementation: IS0214) that resulted in $SIMS_{DAIRY}$´s development. He led this development liaising successfully with other disciplines' researchers (e.g. soil quality: Prof. Scholefield, milk quality and animal welfare: Prof. Dewhurst (IGER-Aberystwyth), grassland biodiversity: Prof. Hopkins (IGER-NW), phosphorus losses (Dr. Davison from ADAS), manure management: Dr. Schröder (Wageningen University), farm economics: Butler A (Exeter University) and also with different stakeholders (policy makers, farmers, NGOs…).

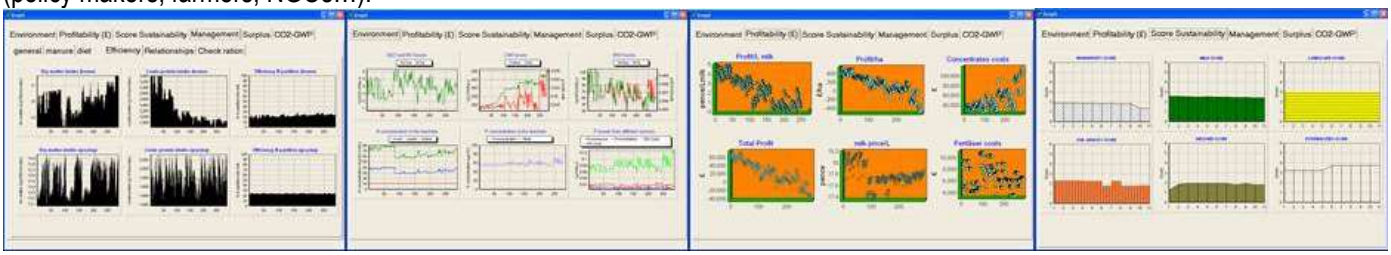

Fig 11. Examples of $SIMS_{DAIRY}$ output user interface.

The description of $SIMS_{DAIRY}$ has been published in the high impact journal ***Science of total Environment***: del Prado et al. (2011a), in different congresses: Del Prado & Scholefield, 2006; Del Prado et al. (2006d) and as part of the final S0214 DEFRA report: del Prado et al. (2009a). Since 2006 the $SIMS_{DAIRY}$ model has been used in different UK projects and international studies in order to provide with key and strategic information useful to assist policy makers on decisions that affect the sustainability of dairy farming grassland-based systems. Amongst other functionalities, $SIMS_{DAIRY}$ has an optimisation routine to balance conflicting targets of production and environmental constraints. Amongst other applications $SIMS_{DAIRY}$ has been used:

- For an International comparison of whole-farm models to simulate GHG emissions from dairy systems, published in Schils et al. (2007***) Livestock Science*** and defended as an invited key-note speech at a European Grassland Federation meeting.
- To compare the scope to achieve farm sustainability by either farm management (e.g. manure, feeding…) *or* genetics (breeding) at grass/clover and animal level. This work was published by Del Prado & Scholefield (2008) ***J agric. Sci.*** Plant breeding was also tested by Del Prado et al (2011b), where experimental data at the plant and animal level on high sugar grasses developed at Aberystwyth University was used to calibrate $SIMS_{DAIRY}$ and to explore the full implications of these new breeds on the whole farm performance of a dairy farm.
- To assess potential GHG mitigation options to reduce GHG emissions from dairy farming systems. This study sheds light on the non-linearities of single and combined measures and the trade-offs on other sustainability attributes. This work was published in high impact journal ***Agri. Ecosyst. Environ*** by Del Prado et al., (2010a) and some of its novelty has been highlighted by, for example, relevant FAO documents on livestock and climate change.
- To study potential trajectories of dairy farming towards sustainable systems and identifying profitability trade-offs that may jeopardise potential win-win trajectories. This work was defended in the Royal Society London in the UK agricultural modellers meeting. A short document is published in the journal ***J agric. Sci.*** (Del Prado *et al.,* 2009b).
- To compare in terms of sustainability conventional and organic UK dairy systems, and also the potential to optimise mineral fertiliser application. This exercise is published in Del Prado et al. (2011a) ***Science of total Environment.***
- To assess the scope of different measures targeting the reduction of enteric CH_4 fermentation output in dairy, beef and sheep farming systems at farm and national level. Experimental data at the plant and animal level developed at Aberystwyth University and University of Reading were used to calibrate $SIMS_{DAIRY}$ to explore the full implications of measures on the whole farm performance of a dairy farm. This work was carried out under the CC0270 DEFRA project ***The implications of farm-scale methane mitigation measures for long-term national methane emissions*** and defended in the Royal Society London in the UK agricultural modellers meeting. A short document is published in the journal ***J agric.***

Sci. (Mills *et al.,* 2007), conference (Dragosits et al., 2008) and as part of the final CC0270 DEFRA project (Chadwick et al., 2007a).

- To assess the effect of different diet strategies on the sustainability of a dairy system. This study was published as a chapter of a book (Del Prado et al., 2006b).
- To assess the impact of climate change on livestock productivity and environmental losses in the UK. This work was carried out under the DEFRA project Climate change impacts on the livestock sector (AC0307) and published as a working paper (Del Prado et al., 2009c), conference (Del Prado et al., 2011c) and as part of the final AC0307 DEFRA project (Moran et al., 2011). The project involved a strong collaboration with the Meteorological Office (Hadley Centre, UK), through regional daily and monthly temporal resolution climatic data HadRM3 model results) and the Scottish Agricultural College (SAC) (grassland and livestock modelling).

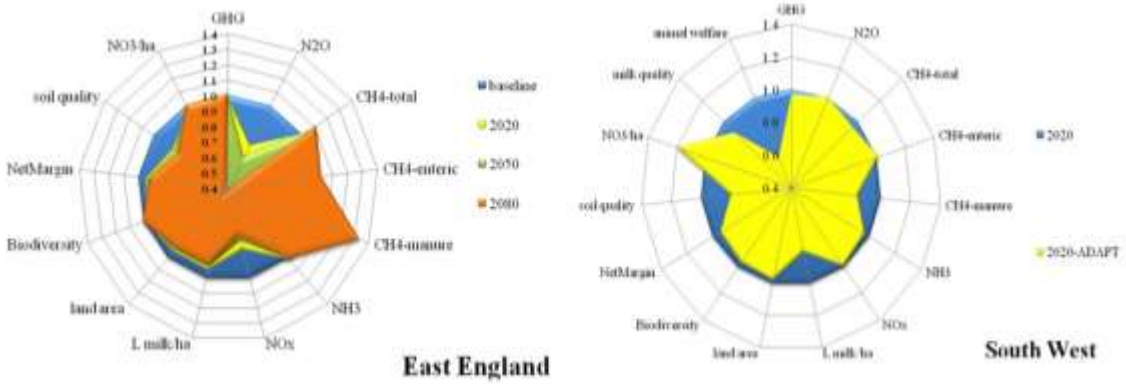

Fig 12. Comparison between (1) East England: baseline and 2020s, 2050s and 2080s for selected variables indicating environmental pollutants and other sustainability attributes and (2) South West: 2020s with and without adaptation of grazing potential days for selected variables indicating environmental pollutants and other sustainability attributes. Values < 1 implied improvement over baseline scenarios.

NGAUGE

The **NGAUGE** Decision Support system (DSS): This was a highly innovative tool that was developed in order to optimise timing and dose applications of fertilizer in grazed or cut grasslands using a novel criteria to balance productivity and N environmental losses and being able to use different targets (e.g. animal productivity, N fertilizer amount, N losses…).

Fig 13. Examples of NGAUGE input and output user interface.

The description was published by Brown et al. (2005) in the high impact journal ***Agri. Ecosyst. Environ.*** Amongst other applications NGAUGE has been used:

- to assess whether there was scope for improving the current UK NVZ action plan (for dairy farming) through production of alternative rules to those specified by the Nitrates Directive that would result in both: (a) small economic penalties for the farmer, (b) annual concentrations in the leachate below the Nitrates Directive threshold (11.3 mg/L NO_3^--N) and acceptable losses on other N pollutants (avoiding the so-called pollution swapping as N_2O or NH_3).
  This study was part of two strategic contracts requested by DEFRA {NT2506 project: Evaluation of the NGAUGE DSS in the provision of guidelines for sustainable N management by livestock farmers in NVZs NT2506 and Development of a case to justify a higher application limit of organic manures to grassland systems, or mixed grassland/arable systems, than the 170 kg N/ha limit set by Annex III of the Nitrates Directive} and **was successfully used as part of the scientific basis of the UK to derogate some of the general EU NVZ action plan rules** on fertiliser management in the NVZ designated areas (limit of 170 kg N/ha yr) (below).

  The scientific study was also defended as an invited presentation in the Royal Society London at the 36th Meeting of the Agricultural Research Modeller's Group and a short document of this presentation was published in the journal ***J agric. Sci.*** (Del Prado *et al.,* 2004a). This work was also defended as an invited presentation in the 12th Nitrogen workshop (Del Prado et al., 2004b) and as part of a key-note speech in the British Society of Soil Science meeting (Scholefield et al. 2003).
- To study cost-efficiency of abatement measures for reducing NO_3^- leaching from grassland-based livestock systems in the UK. This work was carried out under the context of a DEFRA project (NT2511-Cost Curve of Nitrate Mitigation Options) and apart from the published DEFRA project final report, the study was published in the high impact journal ***Science of total Environment*** (Cardenas et al., 2011a) and highlighted by the European Commission, as policy relevant, by their EU ***Science for Environment Policy*** online service (Cardenas et al., 2011b). Part of this study was defended as an oral presentation at the Second International Conference on Greenhouse Gases and Animal Agriculture (GGAA) held in Zurich (Del Prado et al., 2005).
- To assess N losses for the strategy of extending the grazing season in the UK. This work was carried out under the context of a DEFRA project (NT2509-Nitrogen flows on farms for extended grazing).
- To study new indicators for assessing dairy farm sustainability. This work was carried out under the context of a DEFRA project (NT1854-Development of indicators for nutrient management of dairy farms).
- To investigate the environmental impact of using Forage brassicas for out-wintering livestock in the UK. Using experimental data developed a new N response growth curve for kale within the NGAUGE model and was subsequently calibrated to simulate N flows and losses from kale grazing in winter periods This work was carried out under the context of a DEFRA contract (WT0740 CSF-Forage brassicas for out-wintering stock MDC/Defra Project 06/09/B) and its report was published (Chadwick et al., 2007b).
- To assess N losses in Atlantic European dairy systems. This work was carried out under the context of an EU Interreg III-B project: Atlantic Dairy Systems and Environment. Green Dairy and involved the

calibration of the model for grassland systems in France, Spain and Ireland and the development of a simple version for forage maize.

NCYCLE_IRL

As part of a contract commissioned by the Environmental Protection Agency in Ireland Agustin was the main developer of this mass balance model to simulate N flows in grazed and mowed systems in Ireland. The work involved liaising strongly with Irish-TEAGASC scientists and was very much focused on producing a tool that could be used to predict NO_3 leaching losses as a result of nutrient management, soil and weather conditions. The description of the model and different applications were published in the final report (Del Prado et al., 2007a) and in the peer review journal ***Nutrient cycling in Agroecosystems*** (Del Prado et al., 2006a).

Fig 14. Examples of NCYCLE_IRL input and output user interface.

LANAS

The **LANAS** modelling framework: Different existing models (including the NGAUGE) were integrated into a single tool called LANAS in order to study N flows and losses at the landscape scale. This work was carried out under the context of a NERC project (NERC/T/S/1999/00123-Landscape analysis of the transport, transformation and fate of reactive nitrogen and abatement strategies LANAS http://archive.ceh.ac.uk/staffarchive/cr/c01713/o129832cr.pdf). The description was published in the peer reviewed journal ***Water Air and Soil Pollution*** (Theobald et al., 2004) and defended as an oral presentation in the Third International Nitrogen Conference (Dragosits et al., 2004).

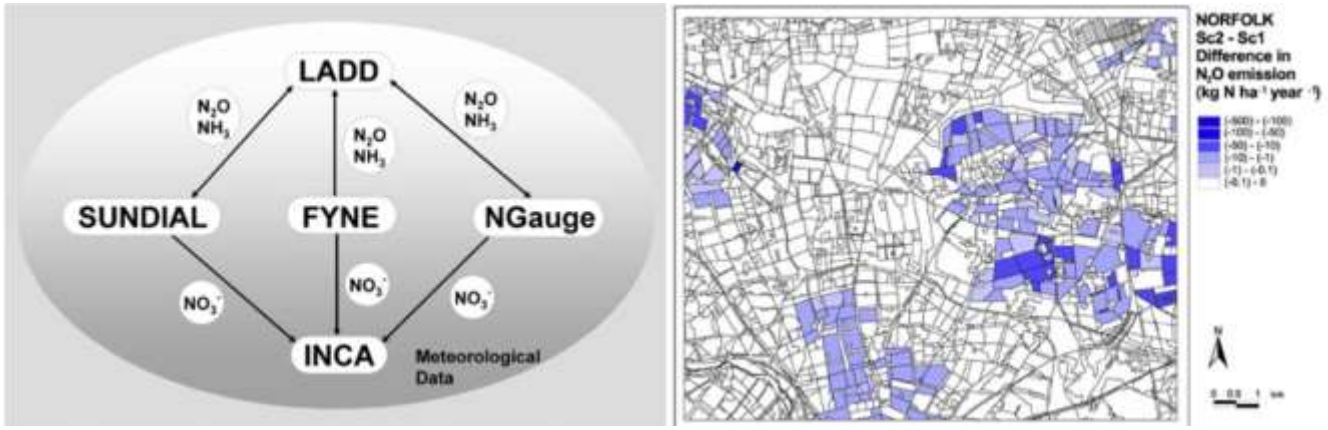

Fig 15. Diagram with main inter-relations between the LANAS models and an illustrative example for N2O modelling at a particular spatially explicit zone in the UK (e.g. Norfolk).

BLUEPRINTS

The **Blueprints** model is a tool that was developed by Agustin as the main developer in order to simulate combinations of the efficiency controls for hypothetical, economically and environmentally sustainable farm systems. This work was carried out under the context of a DEFRA project (IS0101- Blue prints for sustainable nutrient use in grassland livestock production) and was defended at the 15th N Workshop (Del Prado et al., 2007b).

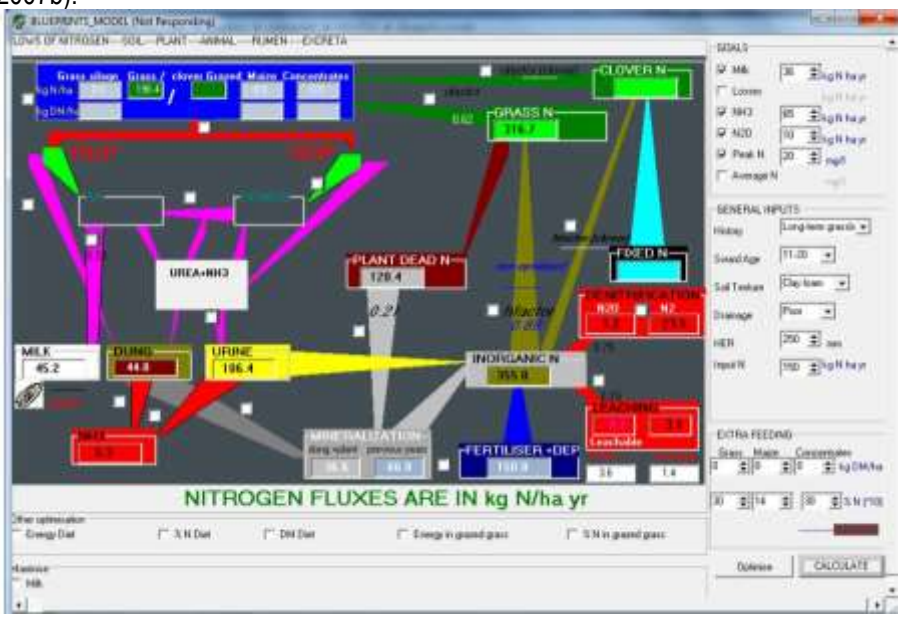

Fig 16. Examples of BLUEPRINTS model user interface.

RUN OFF-BOD

The RUN OFF-BOD model was constructed to determine the ability of 'native' soil to remove biological oxygen demand BOD5 (as a proxy linking with faecal pollution) following application of dirty water under a range of climatic, edaphic and site conditions. This work was carried out under the context of a DEFRA project (LK0650-DW-Stop: Dairy farm dirty water - seeking the best solutions to avoid pollution). The description is found in the final report by Cumby et al (2005).

C MODEL

A new model was developed in order to study the influence of different C composition and amount in soil and amendments on losses from denitrification. Results from a laboratory experiment were used to develop this model. This was carried out within the project "BBSRC-Novel laboratory and field techniques to improve understanding of the denitrification process".

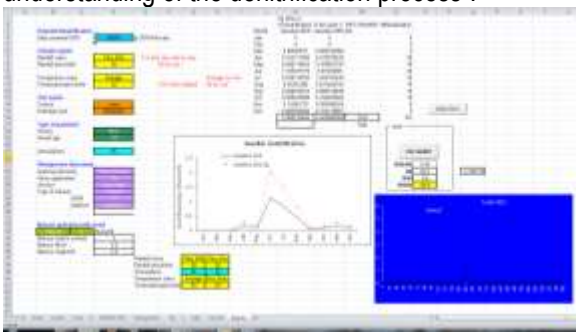

Fig Examples with specific runs in order to estimate the effect of C quality in the amendments and the effect on soil N_2O emissions.

I was the coordinator, president and main founder of the network/association on GHG mitigation from the Spanish agricultural sector (RED REMEDIA https://redremedia.wordpress.com/), comprising over 100 scientists from Spain and Latin America (2012-2017).

General context

Climate change dynamics are the products of complex chains and relationships, natural causes and human effects, across diverse yet connected regions. To build research capacity, advance knowledge and generate potential scientifically-based solutions, this must sprout from a diverse, multidisciplinary and system-based type of network.

The relationship between climate change effects and the whole agri-food chain is particularly complex compared with other economic sectors. Agricultural production and forestry can both contribute to the climate change effect (emissions of GHG) and offers opportunities to mitigate climate change (carbon sequestration through net photosynthesis). Many disciplines are required to provide a comprehensive understanding of the interrelationships and feedbacks amongst the different scales and components that regulate the relationships between the whole agrifood system and land use and issues of food security and provision of ecosystem services and goods. Also, the multi-sector is very singular as it contributes to the largest share of non-CO_2 GHG emissions.

My role on the new network creation

In November 2011, I organised a meeting in Madrid with a selection of 15 of the key Spanish researchers on the topic of Climate Change mitigation from the agroforestry sectors in order to (i) diagnose the state-of-the-art of the science and (ii) gather ideas and feelings around the motivation and necessity of creating a new network/hub on this new multidisciplinary area. Subsequently, once I had a very positive response from these scientists, I organised and coordinated the first meeting of REMEDIA (Bilbao, 2012) https://redremedia.wordpress.com/remedia-workshop/ setting up the basis of the new network that was meant to connect the formidable amount of science that groups in Spain had been producing partly in isolation or collaborating with groups from their own disciplines.

The network was co-created with the enthusiastic help of a mix of established scientists, some with strong experience coordinating other existing Sci networks in Spain (e.g. composting network (REC) or the nitrogen use efficiency network: RUENA) and other less established scientists, that have just been having positions abroad in different countries where climate change scientific strategy was very well structured (e.g. UK, the Netherlands and US).

Objectives

One of the main objectives was to enable a structure that foster inter/multidisciplinarity collaborations in order to comprehensively address all or most dimensions, in an integrated way, of the challenge in relation to climate change and the agroforestry sector. This approach has led to studies that provided a more added value in an integrated way than carried out in isolation. Additionally, it also became key in our mission to make large efforts on disseminating the scientific findings to the different stakeholders in the society and to engage with them as much as we could.

After 5 years the network has been successful in many ways (examples):

- 5 annual workshops with about 100 participants and top international and national key-note speakers
- Different working groups that have produced over 20 publications in peer-reviewed journals. https://redremedia.wordpress.com/grupos-de-trabajo/
- Articulation of national and international consortiums for projects and PhD/MSc students
- Producing specific courses on the topic (e.g. IAMZ-CIHEHAM)
- Producing 2 special issues in Q1 international journals (Agricultural Ecosystems and Environment and Mitigation And Adaptation Strategies For Global Change).
- Intense activity in social networks: Blog: https://redremedia.wordpress.com/ (over 500 followers from over 30 different countries and 200 posts), Facebook (over 300 followers and 500 posts) and twitter (over 600 followers and 3000 tweets).
- Engagement with policy makers
- International collaboration through networks like Global Research Alliance or FACCEJPI http://bit.ly/1NuE21W

My specific roles in the network (a selection)

- Coordination and public representation of the network
- Coordinating the communication with public state bodies (e.g. OECC and INIA).
- Attracting funds through Spanish and Basque calls for Organisation of workshops and web development.
- Coordinating a successful project proposal bid from the Biodiversity Foundation.

http://fundacion-biodiversidad.es/sites/default/files/multimedia/archivos/resolucion_final_conv._ano_2014.pdf

- Transformation of the network into a formal association https://redremedia.wordpress.com/2014/01/01/somos-asociacion/
- Coordination and main author of Website http://www.redremedia.org/ , Blog https://redremedia.wordpress.com/ , Facebook and twitter
- Co-Coordinating and lecturing on the advance course for professionals IAMZ-CIHEHAM course: "Greenhouse gas assessment and mitigation in agriculture: concepts, methods and simulation tools" http://www.iamz.ciheam.org/download/140
- Coordinating efforts to open the RED REMEDIA to the society (Seminar in Bilbao: Opening REMEDIA doors to society) https://redremedia.wordpress.com/2014/11/10/abriendo-remedia-a-la-sociedad/
- Coordinating efforts to engage Latin American scientist and FONTAGRO.
- Coordinating the involvement of members of RED REMEDIA in different strategic discussions (e.g. with Vietnam Sci. representatives, Global Research Alliance on GHG emissions). https://redremedia.wordpress.com/2014/08/12/la-red-remedia-llega-a-vietnam/
- Guest Special Issue co-Editor: Mitigation and Adaptation Strategies for Global Change: "Greenhouse gas mitigation in agricultural, livestock and forestry sectors in Spain" https://link.springer.com/journal/11027/21/7/page/1
- Member of Organisers Committee of fourth REMEDIA workshop Madrid (2015) http://www.redremediaworkshop.org/
- Member of Scientific Committee of second, third and fourth workshop RED REMEDIA in Zaragoza (2013), Valencia (2014) and Madrid (2015) https://redremedia.wordpress.com/workshops-remedia/
- Participating in the crop modelling REMSAE working group https://redremedia.wordpress.com/2013/12/17/constitucion-del-grupo-de-modelizacion-de-sistemas-agricolas-espanoles-de-remedia-remsae/
- Coordinating the manure management group (presented joint work at the international RAMIRAN conference) https://redremedia.wordpress.com/2013/07/22/corresponsales-en-el-congreso-ramiran-2013/