FLAGSHIP PROJECT IDEA

GLOBAL RESEARCH ALLIANCE
ON AGRICULTURAL GREENHOUSE GASES

Title of project idea
GHG mitigation in cattle farming - how much is possible where and what are the economic implications on-farm?
Project leader
Thünen Institute
Countries involved
Argentina, Australia, Bangladesh, Belgium, Canada, Germany, Ghana, Peru, Portugal and South Africa. Further countries can be included depending on project partner interest and availability. **Council Champions:** Argentina, Australia, Bangladesh, Canada, Germany, Peru and South Africa
Brief description of idea

Background

The economic perspective on GHG mitigation strategies remains a challenge in global climate research. Especially, the costs of implementation and realization of GHG mitigation strategies at the farm level are not yet well-known, the data needed for economic assessment of GHG mitigation options at farm level is often not available or not comparable. This is of importance, as mitigation potentials, production costs as thus mitigation costs vary between production systems, but also within the same production systems. Countries need cost data to implement their NDCs and decide on how to allocate financial resources to support climate mitigation measures.

Project aim

The project aims to fill the cost data gap. It will investigate the feasibility and cost-effectiveness of GHG mitigation strategies on farm-level. It aims to identify the most cost-effective management and technology options in different global production systems and regions and to provide evidence-based policy recommendations on GHG mitigation strategies at the farm level.

Project description

In the beginning, the project will focus on beef cattle (cow-calf, backgrounding and finishing) as well as dairy farming systems. Production systems in beef and dairy farming differ worldwide, in some cases significantly, in terms of factor input and costs (labour, land, capital), other costs, animal performance and productivity, and GHG emission profile. The production environment also shows some significant differences, e.g. with regard to the availability of resources and infrastructure, climatic conditions or the cultural significance of animal husbandry. Based on the diversity of production conditions, mitigation strategies must be adapted to regional circumstances. The basic hypothesis for this research project is that, given the above, there are significant differences in mitigation potentials and abatement costs.

Climate protection and GHG mitigation are a global challenge. For an effective climate protection policy, analyses based on comparable data sets are necessary. Within the framework of the project, a concept for the harmonised evaluation of GHG mitigation

strategies will be developed, which allows comparisons to be made with regard to costs and potentials across production systems and countries.

The selected partner countries represent globally relevant beef cattle and dairy farming production systems and climatic zones. Data sets are specified to represent locally prevailing production. Locally adapted mitigation strategies are identified, specified and their effects quantified within the framework of calculations for typical farms. This allows us to upscale the farm-level results to the regional level in a second step. The results are analysed with regard to their GHG mitigation potential and costs using a marginal abatement cost curve approach. In addition, possible adoption barriers will be identified. The reduction scenarios are examined for their acceptance by farmers and probability of implementation. The results of the GHG reduction strategies will also be discussed with regard to possible side effects (e.g. rebound or leakage effects). Finally, the results will help to identify the most cost-effective managerial and technological GHG mitigation options per region to provide evidence-based policy advice.

The basis for the comparative analysis of typical production systems is the Standard Operating Procedure[1] used in the *agri benchmark* Network Beef and Sheep.

In focus groups with producers, consultants and local production economists, we collect data on production systems (animal numbers, categories, performance data, feed rations, etc.) and on prices and costs of typical cattle farming systems. For this baseline the economic viability and GHG emissions are calculated.

Some of the partners are already members of the *agri benchmark* Network. Further, the situation in terms of data availability (farm level and emissions) differs. As a consequence, the following option for the next steps are available:
Option a) Add existing GHG emission data to existing typical farm dataset
Option b) Add new GHG emission data to existing typical farm dataset
Option c) Add new typical farm dataset to existing GHG emission data
Option d) New data collection covering economic and emission data
Option e) Compare existing GHG and economic data sets and harmonize

The calculation of production-related GHG emissions is based on internationally recognised methods (IPCC, 2019). The reduction strategies are determined on the basis of local research results and focus groups. For this purpose, the individual production and accounting model TIPI-CAL is applied. The economic analysis is extended by questioning beef cattle and dairy farmers about their willingness to implement reduction measures.

Depending on the interest and involvement of partners in the field of natural science, the analysis can be expanded to further environmental indicators (nutrients, water, biodiversity) as well as animal welfare aspects.

Planned next steps

- Q1/22: Concept paper with flagship project milestones planned for 2022 will be sent out to flagship partners for comments
- Q1/22: Meeting with all flagship project partners to discuss concept paper and final details

[1] Chibanda C, Agethen K, Deblitz C, Zimmer Y, Almadani I, Garming H, Rohlmann C, Schütte J, Thobe P, Verhaagh M, Behrendt L, Tudela Staub DF, Lasner T (2020) The typical farm approach and its application by the Agri Benchmark network. Agriculture 10(12):646, DOI:10.3390/agriculture10120646

- Q2/22: Working paper preparation to be presented at the *agri benchmark* beef and sheep conference, 17th – 22nd June 2022
- Q3+4/22: Develop a publication for peer-reviewed journal

Expected Outcomes

The analysis aims at contributing to the following questions:

- What are the greenhouse gas profiles of typical beef cattle and dairy production systems in different production regions?
- Which greenhouse gas reduction strategies can be applied in the different production systems and regions and what are the associated reduction potential and costs / what are the most cost-effective managerial and technological GHG mitigation options?
- What are the barriers to the implementation of reduction strategies and how high is the probability of adoption in this context?
- What are the potential trade-offs and co-benefits of mitigation strategies?

Based on the calculations on mitigation extent and related costs, we aim to identify the least cost abatement measures for various farming situations.
The developed methodology could be transferred to other sectors, such as sheep farming, pig farming, arable farming or horticulture.

How will you encourage participation by a wide range of members, including low-income countries?

The partners from the *agri benchmark* Network would be available at relatively short notice. Furthermore, participation of members of the GRA Farm to Regional Scale Integration Network is expected. For all research partners involved funding is required for data collection, local travel, regional workshops and presentation of results to local stakeholders. Low income countries in South America, Sub-Sahara Africa and Asia would be addressed with high priority to link them to international research activities and provide capacity building, where required. The involvement of local producers and other experts as well as the dissemination of results is an integral part of the research. The project aims to especially involve young researchers from low-income countries through e.g. CLIFF-GRADS Fellowships or DAAD climapAfrica scholarships.

Benefits to the GRA

- Global scope: several GRA member countries have indicated their willingness and capacity to collaborate on the project. The participation signalled to date covers globally relevant beef cattle and dairy farming production systems and climatic zones.
- Global cost-benefit analysis of GHG mitigation strategies at farm-level in beef cattle and dairy sector: only possible through GRA-wide collaboration.
- Fill the existing research gap on identifying cost-effective managerial and technological GHG mitigation options across regions and complement existing GRA research work with socioeconomic analysis.
- Synergies with GRA work: multiple connecting points, e.g. the mitigation database of the GRA Feed and Nutrition Network, the MELS (Mitigating greenhouse gas emissions from livestock systems) project of the GRA Manure Management Network are suitable for an economic evaluation of the developed technical options.

- Development of harmonized approach to analyze costs and benefits of GHG mitigation strategies to make results comparable between regions and provide evidence-based policy advice on cost-effective managerial and technological GHG mitigation options.
- The methodology is globally applicable, and especially suitable in countries with limited official statistical data availability, as it integrates experts and producer knowledge in the data collection phase.
- Build database for farm-level assessment of GHG mitigation strategies related to costs and benefits

Intended start date and project length

Anytime, 3-5 years depending on number of countries and case studies.

Key partners and existing resources

Depending on the countries selected. Existing partners from the *agri benchmark* countries and GRA Farm to Regional Scale Integration Network can form a basis (see table below). In other countries new partners must be found.

Country	Partner name	Type of resource	Possible length of support
Germany	Thünen Institute	Human resources: • Dr. Claus Deblitz • Katrin Agethen • Nina Grassnick	• Full flagship project length • Full flagship project length • Until April 2024
		Project resources: • International research collaboration on mitigating climate change in agriculture • GHG mitigation in cattle farming - how much is possible where? • Implementing sustainable agricultural and livestock systems for simultaneous targeting of forest conservation for climate change mitigation (REDD+) and peace-building in Colombia (CIAT Project C-073-19)	• Until April 2024 • Full flagship project length • Until December 2022
South Africa		Human resources:	

	Agricultural Research Council	• Prof. Michiel Scholtz • N Thuli Chabalala • Motshabi Chadyiwa • N Olivia Mapholi • Dr Marsia Grobler • Gilbert Pule • Francuois Muller • L Letsoalo • M Kidson • Dr Mokhele E Moeletsi • Idani A Gundula	• March 2025 • September 2022 • September 2022 • September 2022 • March 2025 • March 2025 • March 2026 • March 2025 • March 2025 • June 2023 • June 2023
		Project resources (see appendix): • The farm gate carbon footprint of diverse beef cattle genotypes in South Africa and its environmental impact • Carbon footprint of natural grazed rangeland in relation to extensive beef cattle production • Estimating greenhouse gasses from three livestock production systems in Gauteng	• Until September 2022 • Until March 2025 • Until June 2023
Bangladesh	Bangladesh Livestock Research Institute	**Human resources:** • Nani Gopal Das • Dr. Nasrin Sultana	• Until June 2022 • tbc
		Project resources: • A Gate-to-Gate Analysis of Beef Cattle Carbon Footprint at South-West Region of Bangladesh during Eid ul-Adha	• Until June 2022
Australia	Charles Sturt University	**Human resources:** • Dr. Karl Behrendt	

		• Dr. Sosheel Godfrey	
Peru	Universidad Nacional Agraria La Molina	**Human resources:** • Prof. Dr. Carlos Gomez • Dr. Eduardo Fuentes Navarro	• Full flagship project length • Full flagship project length
		Project resources: • Improving sustainability and resilience of Peruvian Amazon systems through silvopastoralism • Collaborative research project with CIAT and CIFOR/ICRAF on silvopastoral cattle in the Amazonian region • INTEGRITY – Integrated crop-ruminant livestock systems as a strategy to increase nutrient circularity and promote sustainability in the context of climate change	• Until April 2023 • Until April 2024 • Until April 2025
Argentina	Universidad Nacional de Córdoba	**Human resources:** • Florencia Garcia	• Full flagship project length
		Project resources: • Local-adapted GHG mitigation strategies for pastoral livestock systems of the semiarid region of the center of Argentina (see appendix)	
		Human resources: • Dr. María Paz Tieri	

	Instituto Nacional de Tecnología Agropecuaria (INTA)	• Jorge Martínez Ferrer • Dr. Patricia Ricci	
		Project resources: • INTEGRITY – Integrated crop-ruminant livestock systems as a strategy to increase nutrient circularity and promote sustainability in the context of climate change	• Until February 2025
Belgium	Flanders Research Institute for Agriculture, Fisheries and Food (ILVO)	**Human resources:** • Dr. Nico Peiren • Dr. Veerle Van Linden • Dr. Karen Goossens	• Full flagship project length • Full flagship project length • Full flagship project length
		Project resources: • Climate actions with economic potential on farm - Klimrek support (https://www.klim-rekproject.be/) • KlimGras • BovINE WP6 (Climate and environmental sustainability)	• Until August 2023 • Until November 2024 • Until December 2022
	Walloon Agricultural Research Centre CRA-W (tbc)	**Human resources:** • tbc	
Ghana	Council for Scientific and Industrial Research	**Human resources:** • Dr. John K. Nyameasem	• Full flagship project length
		Project resources: • Evaluation of greenhouse gas emissions from grazing ruminants on coastal	• Until September 2023

		grasslands of Ghana	
	Kwame Nkrumah University of Science & Technology (tbc)	**Human resources:** • Dr. Christopher Antwi (tbc)	
Canada	Canfax Research Services	**Human resources:** • Brenna Grant	
		Project resources: • Canadian Cow-calf Cost of Production Network	
Portugal	Algarve University	**Human resources:** • Prof. Maria de Belem • Prof. Miguel Sottomayor (tbc)	• Full flagship project length • Full flagship project length

Further resourcing needs (financial and personnel)

- Financial needs:
  - Participation of Nani Gopal Das in the project after June 2022
  - South Africa will have to commit more finances to the project beyond the finances that are currently committed to ensure participation for the full duration of the project. If South Africa is to align the existing projects fully to the flagship project, more financial sources will be needed. Consideration is underway to leverage additional resources, subject to approval, to make the flagship programme sustainable and explore additional potential projects.
- Personnel needs:
  - Portugal needs researcher to support data collection (e.g. CLIFF-GRADS student)
  - Argentina needs additional personnel support to align existing projects to flagship project (e.g. CLIFF-GRADS student)
  - South Africa will have to commit human resources for the full period of the project
  - Peru needs additional personnel support to complement existing projects to flagship project in order to include cow calf operations

Resourcing mechanisms

As indicated above, the key partners will provide personnel and project resources. Further financial resources have to be found as indicated above.

Linkages

Flagship project activities will be aligned with planned activities of the GRA Farm to Regional Scale Integration Network and ongoing projects of its members.
Collaboration with the MELS project, BovINE project and MACSUR SciPol might also be possible.

Appendix

Local-adapted GHG mitigation strategies for pastoral livestock systems of the semiarid region of the center of Argentina

Introduction

Due to the contribution of GHGs emissions associated with ruminants, several recent reports on diets and food systems have generated much debate on the role of animal-based foods in the human diet. A large portion of consumers have internalized this problem, and this has influenced their meat consumption behavior. The demand of consumers regarding the quality of products and the way in which food is produced are increasing, and imply an important challenge for animal production: how to sustainably supply the growing demand for food of animal origin while addressing consumers' demands.

The Sustainable Development Goals (SDGs) provide a new perspective to consider climate action within the various dimensions of sustainability. In this sense, it has been identified that nine of the seventeen SDGs have direct and significant links with the livestock sector (SDG: 1, 2, 3, 5, 8, 12, 13, 15 and 17). In summary, livestock production plays an important role in various dimensions related to food security and territorial development. Moreover, ruminants have the unique ability to convert fibrous feed that cannot be directly exploited by humans, such as forage, into food products of high nutritional value.

There is global consensus that livestock accounts for an important portion of the GHG emissions. On the other hand, grazing lands have a great potential to sequester carbon dioxide and it has been proposed that they can even change the equation in terms of carbon balance. However, the information of the potential of pastoral systems for carbon sequestration at a regional level is rather scarce. There is a need to consider the system's net global carbon balance, and efforts should be center on reducing emissions while enhancing capture.

The project seeks to provide information on the environmental impact that livestock production has locally, while identifying which strategies would improve the environmental performance of the livestock system in the Semiarid region of the center of Argentina. It is postulated as a hypothesis of this project that, due to the potential of the plants to fix carbon, pastoral-based livestock and with the presence of trees and shrubs, as in the northwest of the province of Córdoba (Semiarid region), could constitute a solution to the problem of GHG accumulation.

Methods

There are several alternatives to reduce GHG emissions from livestock reported in the literature, the question that arises is: which of the existing GHG mitigation strategies would be applicable to livestock systems in the northwest region of Córdoba?

The first step of this project is to identify applicable GHG mitigation strategies. An exhaustive bibliographic search will be carried out to compile all the strategies proposed so far. The strategies will be classified and analyzed taking into account the scale of application (animal or system), the type (nutritional, pasture management, etc.), the mitigation potential, as well as technical and economic aspects. To define the feasibility of implementation, local farmers will be consulted. The identification of the mitigation strategies applicable to the livestock systems of the northwest of Córdoba will be carried out by contrasting the characteristics analyzed in the first instance with the characteristics of the livestock systems. The second step will be to calculate the carbon balance, following the suggestions of the IPCC guidelines (2006).

Results

This project started in middle 2019; it is in early stages and no results are available so far.

Conclusions

There is a need for changing the perspective of analyses when analyzing the contribution of animal-food production to climate change. Not only livestock plays an important role in various dimensions related to food security and territorial development, but also pastoral production

systems could potentially be a part of the solution if we focus in the carbon balance rather only in the emission.

Policy/practice relevance

There is an urgent need to investigate the potential of pastoral livestock systems in our region to answer the question of whether livestock is a source of a problem or an alternative solution to climate change. This project proposes to address this complex question, while identifying which strategies would improve the environmental performance of the livestock system. If the hypothesis that pastoral livestock systems are part of the solution to global warming is confirmed, this information will have high strategic value for our region.

As a final product, it is expected to obtain and provide concrete information to recommend public policy guidelines, plans / programs for extension and training, etc. intended for sustainable livestock development. Findings will allow policy makers to make educated decisions when formulating funding opportunities and policies aimed to accelerate the transition towards low carbon livestock production systems and increase the production and access of high-quality protein.

Possible collaboration of South Africa in the GRA Flagship project "GHG mitigation in cattle farming"

Initially South Africa only submitted one possible proposal, but it has since been extended to three project ideas. They are summarized below.

1. **The farm gate carbon footprint of diverse beef cattle genotypes in South Africa and its environmental impact**" can be considered as part of the project.

Research staff: N.T. Chabalala, M.C Chadyiwa, M.M. Scholtz & N.O. Mapholi
Aims and objectives
To estimate the current farm-gate carbon footprint of the major beef breeds in South Africa that is representative of the different breed types e.g. Sanga (Indigenous), Sanga derived, Zebu, Zebu derived, British and European breeds.
Anticipated outcome
The quantification of the carbon footprint of the major South African beef breeds and its environmental impact can supply information to develop an emissions baseline for the Agriculture, Forestry and Other Land Use (AFOLU) sectors.
The information can be used to develop a model that can estimate the farm-gate methane emission intensity for different breed types, production levels and production systems. Information on South African production systems, production levels and breed types will be available for the estimation of country specific carbon footprints of beef production.
Funder
Department of Agriculture, Land Reform and Rural Development (DALRRD)
Duration
Until September 2022

2. Carbon footprint of beef cattle production in relation to natural grazed rangeland

Research staff: S M Grobler, M M Scholtz, G Pule, F Muller L Letsoalo & M Kidson
Aims and objectives
To determine the carbon and water footprint of extensive beef cattle grazing natural rangeland in the Sourish Mixed Bushveld.
To relate cattle methane production, measured with a Laser Methane Detector, to the water use efficiency and rangeland condition over different seasons and years.
(With additional funding soil microbial population and rangeland carbon balance can be investigated to quantify soil carbon sequestration within grazed rangeland)
Anticipated outcome
Results obtained will make it possible to calculate the carbon footprint of beef cattle grazing natural rangeland. Obtaining local results will prove useful in future modelling activities.
Relating enteric methane production with rangeland water use efficiency and rangeland condition over different seasons and years will shed light on the dynamics of rangeland condition and cattle's greenhouse gas emissions.
Funders
Red Meat Research and Development South Africa (RMRD SA)
Agricultural Research Council (ARC)
Duration
Until March 2025

3. Estimating greenhouse gasses from three livestock production systems in Gauteng

Research Staff: M Moeletsi & I A Gundula
Aims and objectives
The study aims to estimate the amount of GHG's emitted from three beef cattle production systems, mainly focusing on inputs, on-farm operations, and outputs. In addition, a sensitivity analysis will be carried out to assess the sensitivity of the calculations to estimations of input parameters and to assess possible mitigation options.
Anticipated outcome

There is a need for more detailed information on GHGs emissions, mainly from beef cattle production, since research suggests that cattle production emits more GHGs than other agricultural activities. Most analyses to estimate GHG emission factors are based on literature and default values.

Funder
Agricultural Research Council (ARC)

Duration
Until June 2023