SENSE - Synergies in integrated systems:

Improving resource use efficiency while mitigating GHG emissions through well-informed decisions about circularity

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Abstract

Specialization and the often-resulting spatial separation of crop, livestock, and forestry production systems lead to loss of biodiversity and contribute to climate change. Integrating or combining crop, livestock, and forestry offer numerous opportunities to reduce the environmental impacts of agricultural production systems. Circular systems have been proposed to increase the efficiency of resource use, especially for scarce nutrients, and to use them more sustainably than conventional systems.

Therefore, the project SENSE aims to contribute to the study of integrated systems to gain a solid knowledge on the environmental impact of circular agroforestry systems (livestock-agroforestry, crop-agroforestry, and livestock-crop-agroforestry). In addition to the European partners of this project (Germany, Netherlands, United Kingdom and Italy), the expertise of more than 20 years of intensive research on these kinds of systems from the partners from South America (Argentina, Brazil and Uruguay) will be provided. Objectives in this project are to further develop indicators for effective quantification of the status of circularity, near real time measurements of greenhouse gas (GHG) emissions and prediction of emissions and nutrient fluxes through modelling. In order to assess the impacts of climate compatible management measures in a system-oriented way, multidimensional sustainability assessments with different tools (SMART, RISE, TAPE) will be carried out (Hani et al. 2003; Schader et al. 2016; Mottet et al. 2020).

The project activities will be based on case studies of farms and experimental sites of the different participating project countries. The core is formed by benchmark farms where the objectives (indicators for circularity, GHG emission, modelling, sustainability assessment tools) will be applied. The nutrient fluxes and GHG emissions of these farms, as well as trade-offs of further societal demands and ecosystem services, will be recorded and optimized. In a second group of farms (participatory), a scenario-based approach will be used to compare them according to their potential of reducing GHG emissions and investigate farmer acceptance of management practices to increase circularity. Leveraging information from individual farms and involving farmers at multiple levels and times during the whole activities will be crucial to the outcome of our project.

Our project will therefore address, among others, the questions which circular activities in integrated (crop, livestock, and forestry) systems lead to potential GHG reductions at the farm level, what are the externalities that determine the extent of circularity at the farm level, and what are the impacts of circularity measures in crop, livestock, and forestry systems on the SDG target 13 " Climate Action" and on other major challenges, such as biodiversity and appropriate incomes for farmers. The SENSE project will contribute to the European Union's net zero emissions target, the European Farm to Fork strategy and to the cross-cutting actions of the European Circular Economy Action Plan(Montanarella and Panagos 2021). Circularity is considered a prerequisite for climate neutrality, but has potentially negative impacts on other major societal challenges. We will provide guidance for informed decisions on circularity at the farm level, considering trade-offs with other sustainability goals.

Hani F, Braga FS, Stampfli A, et al (eds) (2003) RISE, a Tool for Holistic Sustainability Assessment at the Farm Level. International Food and Agribusiness Management Review. https://doi.org/10.22004/ag.econ.34379

Montanarella L, Panagos P (2021) The relevance of sustainable soil management within the European Green Deal. Land Use Policy 100:104950. https://doi.org/10.1016/j.landusepol.2020.104950

Mottet A, Bicksler A, Lucantoni D, et al (2020) Assessing Transitions to Sustainable Agricultural and Food Systems: A Tool for Agroecology Performance Evaluation (TAPE). Frontiers in Sustainable Food Systems 4:252. https://doi.org/10.3389/fsufs.2020.579154

Schader C, Baumgart L, Landert J, et al (2016) Using the Sustainability Monitoring and Assessment Routine (SMART) for the Systematic Analysis of Trade-Offs and Synergies between Sustainability Dimensions and Themes at Farm Level. Sustainability 8:274. https://doi.org/10.3390/su8030274

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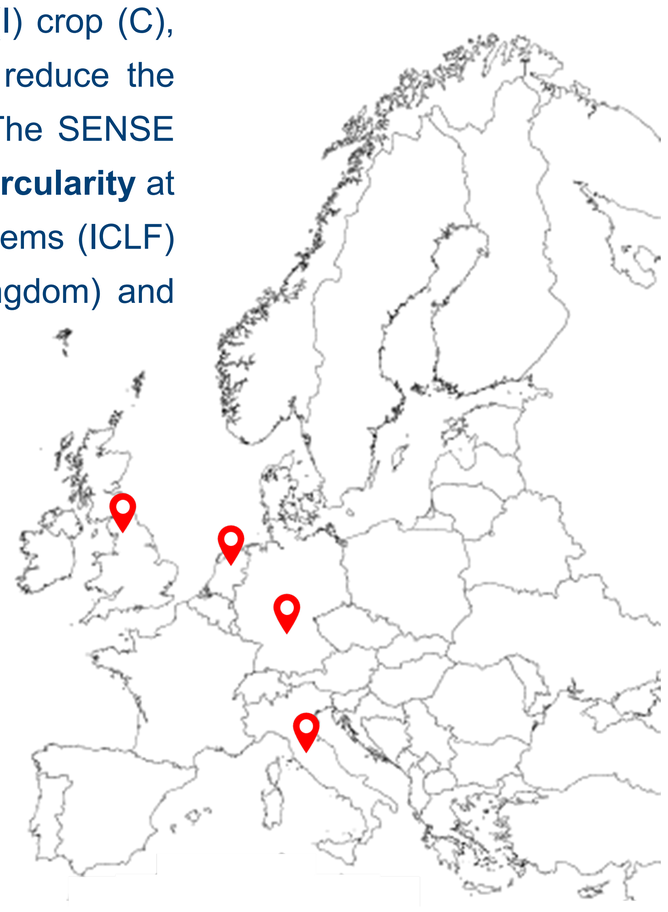
Background:

Specialization and the spatial separation of **crop, livestock, and agroforestry** production systems lead to loss of biodiversity and contribute to climate change. Integrating (I) crop (C), livestock (L), and agroforestry (F) in agriculture offer numerous opportunities to reduce the environmental impacts of agricultural production systems, e.g. **GHG emissions**. The SENSE project (2021 ERA-NET Joint Call) will provide guidance for informed decisions on **circularity** at farm level by investigating **case studies** with integrated crop-livestock-forestry systems (ICLF) in four **European** countries (Italy, Germany, the Netherlands, and the United Kingdom) and three **South American** countries (Argentina, Brazil, and Uruguay).



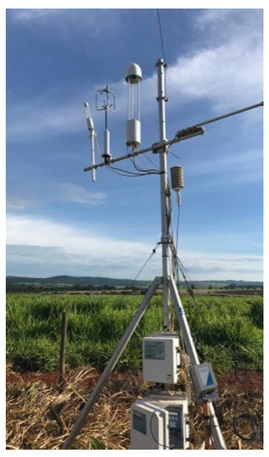
Objectives:

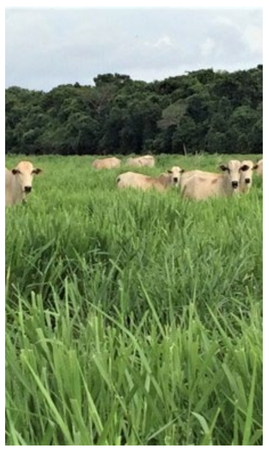
- Developing **indicators** for effective quantification of the status of **circularity**
- Near real time measurements of greenhouse gas **(GHG) emissions**
- Prediction of emissions and nutrient fluxes through **modelling**
- **Multidimensional sustainability assessments** with different tools (SMART, RISE, TAPE)

Case studies

WP1: Centralized database

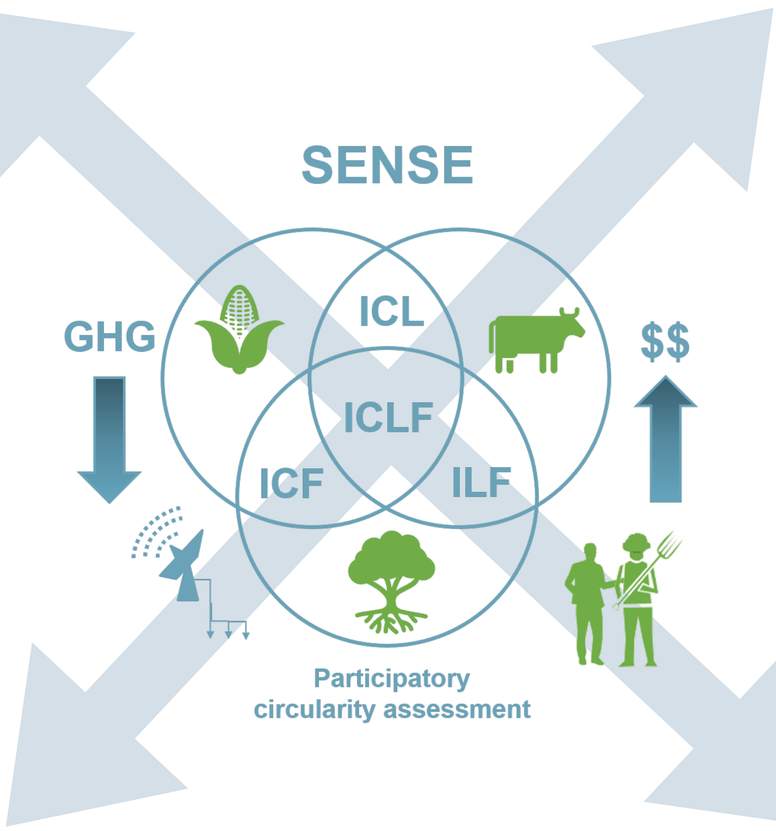
Datasets of case studies (CS): environmental, agronomic, zootechnic and socio-economic

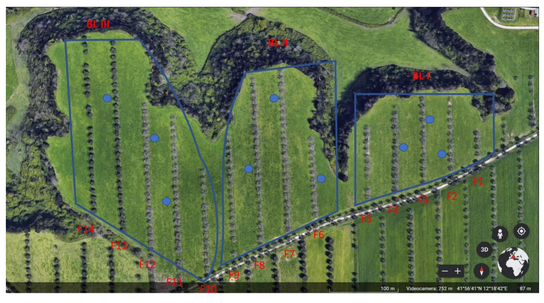




WP2: Circularity metrics

Investigation of current state of CS circularity and near real-time GHG emission estimation





WP3: Alternate, contrasting scenarios

Use of e.g. manure-DNDC model to find optimal circularity measures

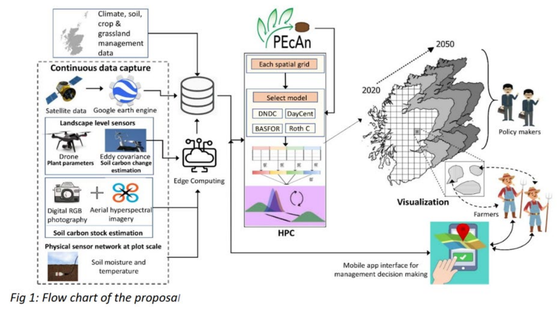
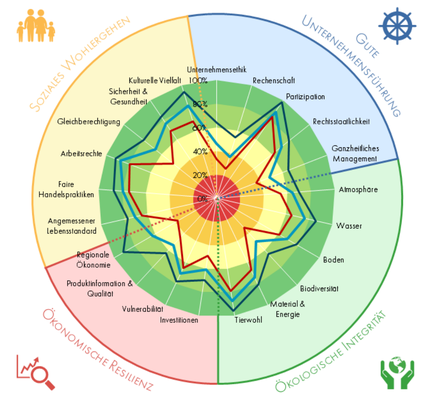


Fig 1: Flow chart of the proposal



WP4: Multidimensional assessment

Evaluation of status quo on farms with sustainability assessment tools

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