Synergies in Integrated Systems

Improving Resource Use Efficiency While Mitigating GHG Emissions

Through Well Informed Decisions about Circularity

D1.2 Technical Briefs – Uruguay

Authors: Carlos Francisco Brazão Vieira Alho[1] (carlos.brazaovieiraalho@wur.nl); Verónica Ciganda[2]; Maria Virgina Paiva[2] and Carolina Viñoles[3]

Affiliations: [1]Stichting Wageningen Research (WUR), the Netherlands; [2]Instituto Nacional de Investigación Agropecuaria (INIA), Uruguay and [3]Universidad de la República (UdelaR), Uruguay

Project Partners:

Funders:
The author(s)/editor(s) acknowledge the financial support through the partners of the Joint Call of the Cofund ERA-Nets SusCrop (Grant N° 771134), FACCE ERA-GAS (Grant N° 696356), ICT-AGRI-FOOD (Grant N° 862665) and SusAn (Grant N° 696231).

Project summary

Acronym	SENSE
Title	Synergies in integrated systems: Improving resource use efficiency while mitigating GHG emissions through well-informed decisions about circularity
Call	2021 Joint Call ERA-NET Cofund ICT-AGRI-FOOD, FACCE ERA-GAS, SusCrop and SusAn: Circularity in mixed crops and livestock farming systems with emphasis on climate change mitigation and adaptation
Duration	36 months
Website	https://sense-eranet.hutton.ac.uk/
Coordinator	The James Hutton Institute (JHI)
Partners	Centre for Ecology and Hydrology (CEH) University of Bristol (UOB) Stichting Wageningen Research (WUR) University of Hohenheim (UHOH) Demeter e.V. (Demeter) Consiglio per la ricerca in agricoltura e l'analisi dell'economia agrarian (CREA-AA) Brazilian Agricultural Research Corporation (Embrapa) National Institute of Agropecuarian Technology (INTA) Instituto Nacional de Investigación Agropecuaria (INIA)

Deliverable summary

Work package	WP1: Standardized data collection : SENSE centralized database
Task	Task 1.2: Preparing the Technical Briefs
Deliverable	D1.2: Technical Briefs
Responsible partner	WUR

Contents

1 Introduction

Specialization, intensification and spatial separation of crop, livestock and forestry production systems have contributed to climate change and biodiversity loss. Circularity in integrated crop-livestock-forestry production systems may reduce the environmental impact of agricultural production systems by increasing resource-use efficiency while simultaneously mitigating greenhouse gases (GHG) emissions. The SENSE project (2021 Joint Call on Circularity) operates in various case studies involved in integrated crop-livestock-forestry systems in four European countries (Italy, Germany, the Netherlands, and the United Kingdom) and three South American countries (Argentina, Brazil and Uruguay).

The case studies conducted by SENSE can be classified into two categories, namely benchmark and participatory, depending on the availability of historical data and the data generated during the project. These case studies may take place on either an experimental station of a project partner or a commercial farm. In benchmark case studies, sensors will be deployed to enable near real-time monitoring of soil and climate properties (i.e. soil temperature and moisture, air temperature, rainfall, etc), to model GHG emissions and carbon and nutrient cycling (WP3). Circularity and ecological indicators will be assessed (WP2) and short-term circularity measures will be implemented and tested (WP2 and WP3). Case studies will be further co-assessed with farmers/farm managers with a multidimensional sustainability assessment tool (WP4). This will allow us to assess understanding of the current circularity status of these systems. The data we collect will drive models to determine alternate scenarios for improving resource use-efficiency while simultaneously mitigating GHG emissions (WP3), thus identifying best measures that will improve circularity within these integrated systems. To test the viability of GHG mitigation, options will be co-assessed with commercial farmers and their trade-offs with other ecosystem services and their effects on economic and environmental resilience will be further explored with a multidimensional sustainability assessment tool (WP4).

SENSE case studies in Europe and South America cover different climatic and pedological zones and exhibit different levels of integration in crop-livestock-forestry systems and a diverse range of establishment dates and species integration. A particular strength of the SENSE project is the longstanding experience (> 20 years) that South American partners have with the implementation of these integrated systems.

The aim of this Technical Brief is to present the characterization of the case studies in the SENSE project. This report showcases the case study in Uruguay, which is coordinated by our partner INIA.

2 Task description

In the first year of the project, a data template table has been developed and shared with all case study coordinators to compile the required data for site characterization. Compiled data includes: case study categories (i.e. benchmark, participatory, experimental station, commercial farm); type of integrated system (i.e. Integrated Crop-Livestock (ICL), Integrated Crop-Forestry (ICF), Integrated Livestock-Forestry (ILF), Integrated Crop-Livestock-Forestry (ICFL)); time under integration; area; climate and soil classification; as well as a brief description of the crop, livestock and forestry components. The results are presented in this document.

3 Case study in Uruguay

In beef production countries as Uruguay, the SSPs are alternative systems for production and rational land use, characterized by the simultaneous integration of the components - herbaceous, shrubby/arboreal and animal - in the same productive management unit. The introduction of trees to livestock systems could help to increase production restrictions, improving calf rearing and cow reproductive efficiency through the reduction of thermal stress. The microclimate generated under the tree canopy has been shown to improve forage quality, reduce heat stress, and increase animal productivity. Therefore, an improvement in meat production and reproductive efficiency of cattle in SSP is expected. Furthermore, these systems have the capacity to sequester carbon and reduce the carbon footprint of breeding ecosystems by 443 kg of CO2 eq/ha (Becoña, 2017).

In the countries of the south cone of Latin America, SSPs have hardly been incorporated by livestock farmers due to lack of knowledge of forestry technology and beneficial integration of forestry and livestock sectors. The non-existence of co-innovation platforms has been identified as one of the greatest limitations for the adoption of these systems. There are also other factors such as the socio-economic level of the farmers, the ability to make the initial investment, or just the lack of knowledge about SSPs, which could be holding back their adoption. Therefore, the case study of Uruguay, installed as an experimental platform within a farmer land, will largely contribute to understand and disseminate the advantages of SSPs, as well as to lift many of the limitations that would eventually be identified. This case is one of the benchmark cases of the project. In Table 1 the general characterization of the case study in Uruguay are shown.

Table 1. General characterization of the case study in Uruguay.

Case study	Location	Institution	Experimental Station (ES) or Commercial Farm (CF)	Type of Integrated system	Year of implementation or start of the integration study	Total area (ha)	Crop (others) area (ha)	Livestock (grass) area (ha)	Forestry (tree) area (ha)	Climate classification (Köppen)	Mean Precipitation (mm)	Mean Temperature (˚C)	Soil classification (WRB)
UY1	Cerro Largo	INIA/UdelaR	CF	ILF	2021	27	27 (Native pasture)	27	19,8	Cfa	1100	17,5	Acrisols and Argisols

3.1 UY1

The case study UY1 is a commercial farm, which is located in Puntas de Sauce (32°11'21.14"S 54°14'0.02"W) Cerro Largo department (Fig. 1a). The local climate is classified as Cfa, which is characterized by hot summers and mild winters and frequent precipitation (Fig. 1b).

Temperatures rarely fall below freezing and range from 10 to 16 °C during winter from June to September. During summer (December to March) temperatures range from 21 to 28 °C. Annual precipitation is around 1,100 mm in the south, while it is higher in the centre and north around 1,200 mm, irregularly distributed throughout the year.

There is a weather station climate database supported by INIA with weather stations located in several regions of Uruguay. One of these weather stations is located very close to the case study area. The database is free, and available on-line, which provides daily weather data (http://www.inia.uy/gras/Clima/Banco-datos-agroclimatico).

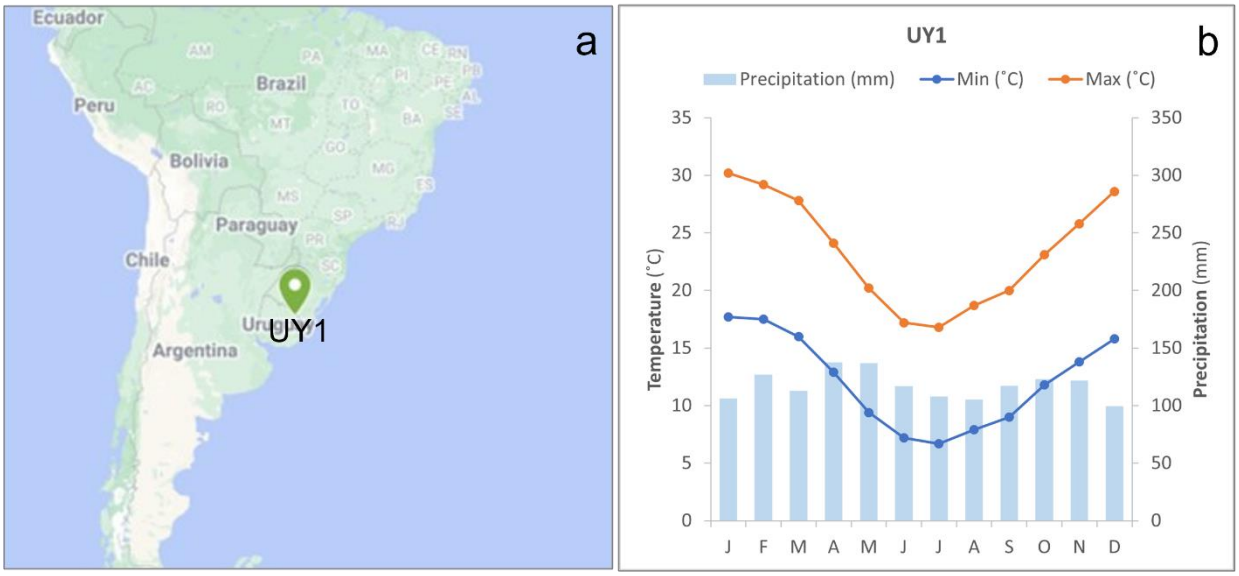

Fig. 1. Location of the case study UY1 (Google Maps© image) (a) and the monthly climatic data for the area (b). Climatic data is derived from a 30-year observed data series. Source: inia.uy

The total area of the case study in Uruguay is 27 ha. This area is within a commercial farm but arranged as an integrated experimental silvopastoral system (ILF), which has been established in 2021, and projected for 15 years, on a native pasture that belongs to the bioma Pampa.

The soil in the area is considered a priority forest soil (classified as group 8.5 in the CONEAT national taxonomy) and it this made up of two soil associations. a) The first occupies large areas between the Corrales and Mangueras streams (Department of Rivera). The landscape is made up of hills non-rocky sedimentary and strong hills, with slopes between 5 and 8%. The geological material it is made up of red sandstones from the Yaguarí formation. The dominant soils are Albic Ochric Acrisols, (Sandy Prairies), deep, dark brown, loamy texture sandy, imperfectly drained and extremely low fertility, and Dystric Argisols Abrupt Melanic (Sandy Grasslands), moderately deep, greyish-brown in colour very dark, imperfectly drained and very low fertility; b) the second association is located between the Zapallar and

Sarandí streams, in the Department of Cerro Largo. The geological material is made up of red sandstones from the Yaguarí formation or sandstones redeposited on it. The landscape is of non-rocky sedimentary hills and strong ridges with slopes of 5 to 10%. The dominant soils are moderately deep Albic Melanic Luvisols (Sandy Prairies), dark brown in colour, sandy loam in texture, imperfectly drained and very low fertility. Associated are Luvisols Umbric Albicos (Sandy Prairies), very deep, dark brown in colour, sandy loam texture, imperfectly drained and extremely low fertility.

The experimental design of the case study consists of a CRBD, based on different arrangement of Eucalyptus grandis tree alleys: two tree densities planted in a north-south orientation, with three repetitions, being the plot the experimental unit. The tree densities are: Treatment 1: zero (control area); Treatment 2: 163 trees / ha - double rows; and Treatment 3: 420 trees / ha - quadruple rows. In the treatments with trees, the spatial arrangement of 5 m of distance between rows, 5 m of distance in the planting row and 20 m of alleys is maintained, both for double rows and quadruple rows.

The plantation of Eucalyptus grandis of seminal origin was established in spring 2020, and its objective is to obtain mechanical transformation wood, a 4-pruning regime was established: 1st pruning: 15-20 months with a pruning height of 1-1.5m (no more than 30% green crown) ; 2nd pruning: 30-35 months with a pruning height of 3 m; 3rd pruning: 45-50 months with a pruning height of 4-4.50 m and a 4th pruning: 60-65 months with a pruning height of 6 m. The evolution of the stand will be evaluated to apply the necessary interventions.

Native pasture is present as the available forage across all alleys between tree lines and in control areas with no trees (27 has). Livestock grazing area is also across all alleys between tree lines within the 27 has. The Forestry area (ha) is limited to 19,8 has within the total of 27 has.

Bovine livestock is present as the animal component of the ILF system and used for beef production purposes (cows and calves). A crossed breeding named Brangus (Angus x Nelore) is managed in a stocking rate which is adjusted at 5 kg of Dry Matter (DM) of available pasture / kg live weight.

Fig. 2. Aerial view (a) and ground view (b) of the case study UY1.

One of the main objectives of the ILF unit of Uruguay is to assess the circularity of the system through the evaluation of the impact of a silvopastoral system on the botanical composition, production and nutritional composition of the forage and on the weight gain, reproductive efficiency and grazing behaviour of calves in their rearing phase and cows during the service period, compared to traditional systems. Climatic variables, sensor data, and all the inputs to the system is being registered. Also, monthly animal body weight is planned to be evaluated to determine the kg / ha of meat produced and the daily gains. The height of the rump and the percentage of animals cycling will be evaluated prior to their first service. In breeding cows, the impact of SSPs at the time of conception, percentage of pregnancy and weight of calves at weaning will be evaluated. To evaluate the animal behaviour in grazing, direct observations will be made and using collars with GPS, the vaginal temperature will be measured using devices that have an automatic recording thermometer attached. GPS will also be used to collect information to follow urine and faeces patches distribution.

4 Outlook

The general characterization of the case studies presented here will be used in other WPs for biophysical contextualization of the case studies in the SENSE project. Results from WP2 (circularity and ecological indicators), WP3 (near real-time monitoring of GHG emissions and carbon and nutrient cycling) and WP4 (multidimensional sustainability assessments) can further enrich the information currently presented here. The Technical Briefs will be uploaded to the project's website for dissemination and communication purposes.