Synergies in Integrated Systems

Improving Resource Use Efficiency While Mitigating GHG Emissions

Through Well Informed Decisions about Circularity

D1.2 Technical Briefs – the Netherlands

Authors: Carlos Francisco Brazão Vieira Alho[1] (carlos.brazaovieiraalho@wur.nl); Marianna Siegmund-Schultze[1] and Sinéad O' Keeffe[1]

Affiliations: [1]Stichting Wageningen Research (WUR), the Netherlands

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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 studies in the Netherlands, which are coordinated by our partner WUR.

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 studies in the Netherlands

The case studies in the Netherlands are categorized as both benchmark and participatory. Table 1 exhibits the general characterization of the case studies in the Netherlands.

Table 1. General characterization of the case studies in the Netherlands.

Case study	Location	Institution	Experimental Station (ES) or Commercial Farm (CF)	Type of Integrated systems	Year of implementation or start of the integrated management	Total area in 2021 (ha) without built area	Crop (others) area (ha)	Grassland area (ha)	% of grassland with agro-forestry	Forest area (ha)	Climate classification (Köppen)	Mean Precipitation (mm)	Mean Temperature (˚C)	Soil classification (WRB)
NL1	Noord-Brabant province	WUR	CF	ILF	2016	78.5	2.5	74.5	23	1.5	Cfb	786	11	Podzol
NL2	Noord-Brabant province	WUR	CF	ILF	2018	22.9	3	19.6	100	0.3	Cfb	746	10	Podzol

3.1 NL1

The case study NL1 is a commercial farm, which is located in Noord-Brabant province (Fig. 1a). The local climate is classified as Cfb, which is characterized by cool summers and mild winters and frequent precipitation (Fig. 1b).

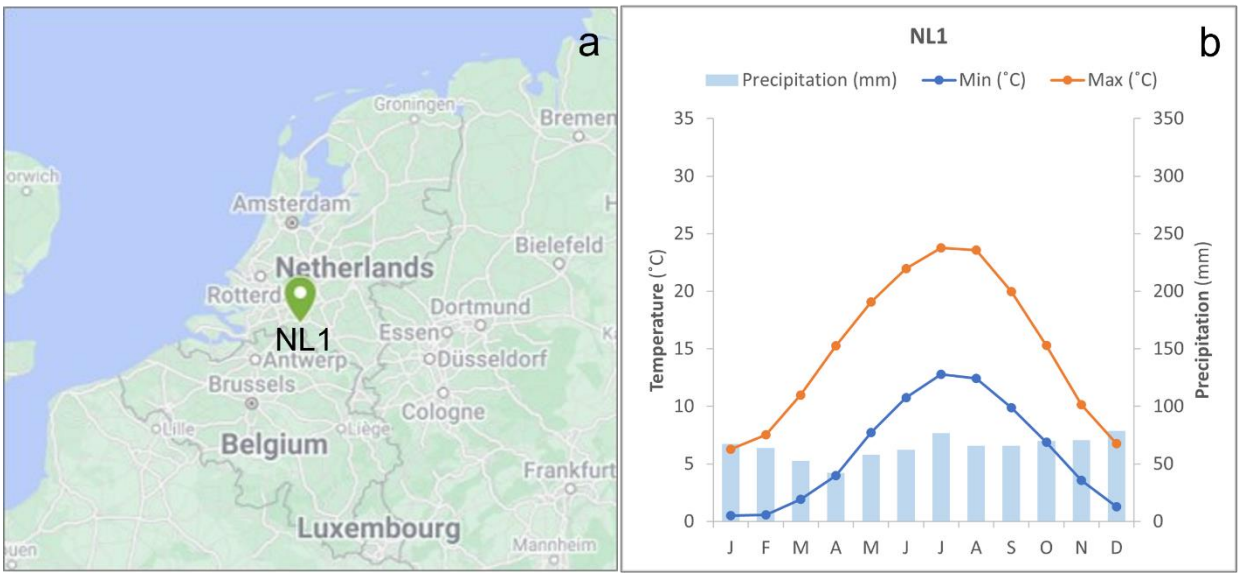

Fig. 1. Location of the case study NL1 (Google Maps© image) (a) and the monthly climatic data for the area (b). Climatic data is derived from a 30-year observed data series. Source: knmi.nl

The farm's center is the so-called house plot of 27.5 ha adjoining the built-up area with stable, milking parlour and residential farmhouse. In our reference year 2021, there were another 11 plots. Eight plots are owned by the farmers (wife and husband), four are leased in on short-time contracts. Two plots are in a nature reserve (Natura 2000). One of the nature reserve areas is meant to be used for cereals in a very extensive way. All other plots are covered with permanent grassland. Soils are sandy. The cows spend most of the time year-round outside. There is solid manure, and slurry produced from the stable and milking unit. The latter is used on leased plots.

In one of the grassland plots, the farmers established so-called "huegels" - woody material buried in the ground, covered with soil, and planted with shrubs, forming a few parallel mini-hill structures. In other plots, the farmers planted walnut and fruit trees in rows, which are wide spaced from each other to allow easy movement of cattle. Walnut trees are fenced per tree, fruit trees are fenced per row. In some other plots, there are shrubby fence structures for biodiversity promotion. The farmers are keen on rewilding their areas and are currently exploring options to do so, both technically and financially. A guiding idea is to minimize costs (and thus external inputs) as much as possible. They imagine their future way of farming as interwoven with nature. One step in this was to officially "downgrade" part of their farming area to allow only extensive farming from then on. This process generated some money from the Province with which they could pay back part of their bank loans. This gave them more freedom in their farming choices. Instead of repaying their loans based on keeping their old system alive, they can a little bit more easily explore new paths now.

The couple underwent already a lot of rethinking and restructuring on their farm. They started with an intensive conventional dairy system with 250 head, comprising all ages. Only later, they converted to

organic farming. They are certified through Skal, the Dutch certification body for the European standard of organic farming. Changes of the conversion included reducing their number of cattle to about 150 by now, keeping the calves with the cows, feeding roughage only, maintaining horns on the animals and testing different breeds for the new purposes, and introducing agroforestry elements. Their current aim is to earn the Demeter certification for bio-dynamic management. So far, their number of animals per ha is still too high to get certified for Demeter.

Eighty percent of farm income is from dairy products, 20% from meat. Major portion is sold through companies, while they also have a small farm shop for direct sales of their dairy and meat products (plus several retail items). Some of the milk is commissioned for processing into cheese and brought back to the farm for sale. A customers' collective was created in 2022 to maintain the shop, since time input became overwhelming for the farming family alone. Customers pay a small monthly share and contribute with a few hours of labour. Additional sources of income are a camping area, a small café in the summer period, and renting or just giving out a small plot for a gardener who works with handicapped people.

The youngest son of the farmer couple is working on the farm too, still besides his off-farm work. He is interested to take over the farm in the future. He supports, shares and adds to the ideas and initiatives of his parents. His aim is to strengthen the entrepreneurial focus to complement and balance the different ongoing environmental developments.

Fig. 2. Ground view (a) and sensor implementation (b) in the case study NL1.

3.2 NL2

The case study NL2 is a commercial farm, which is located in Noord-Brabant province (Fig. 3a). The local climate is classified as Cfb, which is characterized by cool summers and mild winters and frequent precipitation (Fig. 3b).

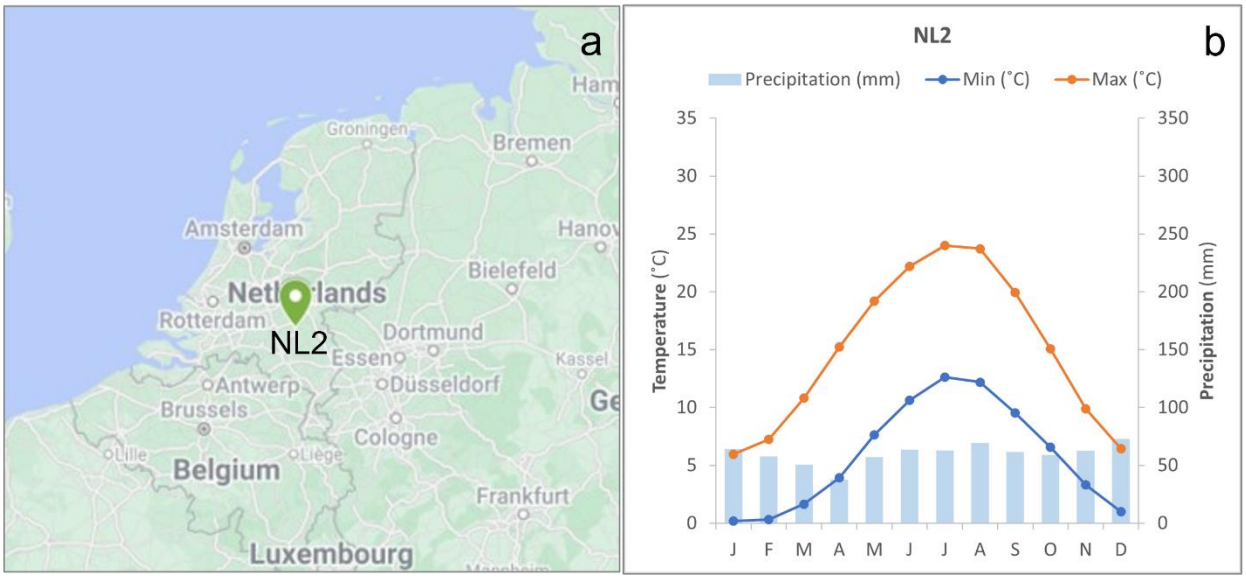

Fig. 3. Location of the case study NL2 (Google Maps© image) (a) and the monthly climatic data for the area (b). Climatic data is derived from a 30-year observed data series. Source: knmi.nl

This farm is equally located and organized around its house plot. Though, all sizes are smaller here. The farm belongs to a Fund through an additional legal construction. The idea of this Fund is to acquire agricultural land and invest in the development of regional farms where nature is part of the system and localness is one principle. In doing so, the Fund aims to create ecological, social and economic added value for society. The farmer is only the owner of his livestock. He works full-time and his wife part-time; she does substantial off-farm work too. There are interns who work temporarily on the farm. The couple has one young kid. Before they started working on the farm, maize was intensively cultivated on the farm's land.

The set-up of the farm was preceded by a design study. The implementation deviates from it, partly since leasing specific plots was not feasible yet. The idealised types where tree galleries, hedgerows, forest meadow, food forest. Hedges associated with fruit trees in parallel lines cutting through the pasture have been planted on the house plot (Fig. 4; 3 sensors installed). They used about 60 different varieties of fruit and nut trees and shrubs. The harvest from the trees is just incipient by now. Smaller growth types were preferred to limit light shade effects but create wind shadows. Cattle and sheep graze on the area. A mobile hen house is moved around on it. The multi-species pastures are meant to be temporary. Fodder beets, purchased cakes (such as from carrot), and concentrates complement the diet of the cattle. Inputs such as feed and seeds are bought from Skal-certified organic production.

The farmer is very keen on increasing the forest area of the farm and managing forest for carbon sequestration. One sensor each is installed in a currently by him managed forest and the other in a piece of forest he is likely to get in the future. The farm started to issue carbon certificates. Several studies from third parties take place in collaboration with the farmer. One of his interests lies in better understanding the fungi-bacteria communities in the soil and how to use this knowledge to steer soil management.

The farm produces own cheese and meat products and sells locally through a farmer-civil society cooperation (since 2022) and their webshop. One product is muesli, which is marketed as forest muesli since containing leaves from lime tree (*Tilia*). Further ingredients are self-grown oats, pumpkin seeds and four types of dried fruit. A small income stream is generated from offering farm visits.

A prominent fault line crosses the farm, where iron-rich groundwater rises as leachate. Soils are sandy, one small area is somewhat wetter (sensor number 5).

Fig. 4. Sensor implementation (a) and ground view (b) and in the case study NL2.

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.