Horizon 2020 Programme
Research and Innovation Action

*This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme, under Grant Agreement **No 773649**.*

Efficient Carbon, Nitrogen and Phosphorus cycling in the European Agri-food System and related up- and down-stream processes to mitigate emissions

Start date of project: 2018-09-01

Duration: 48 months

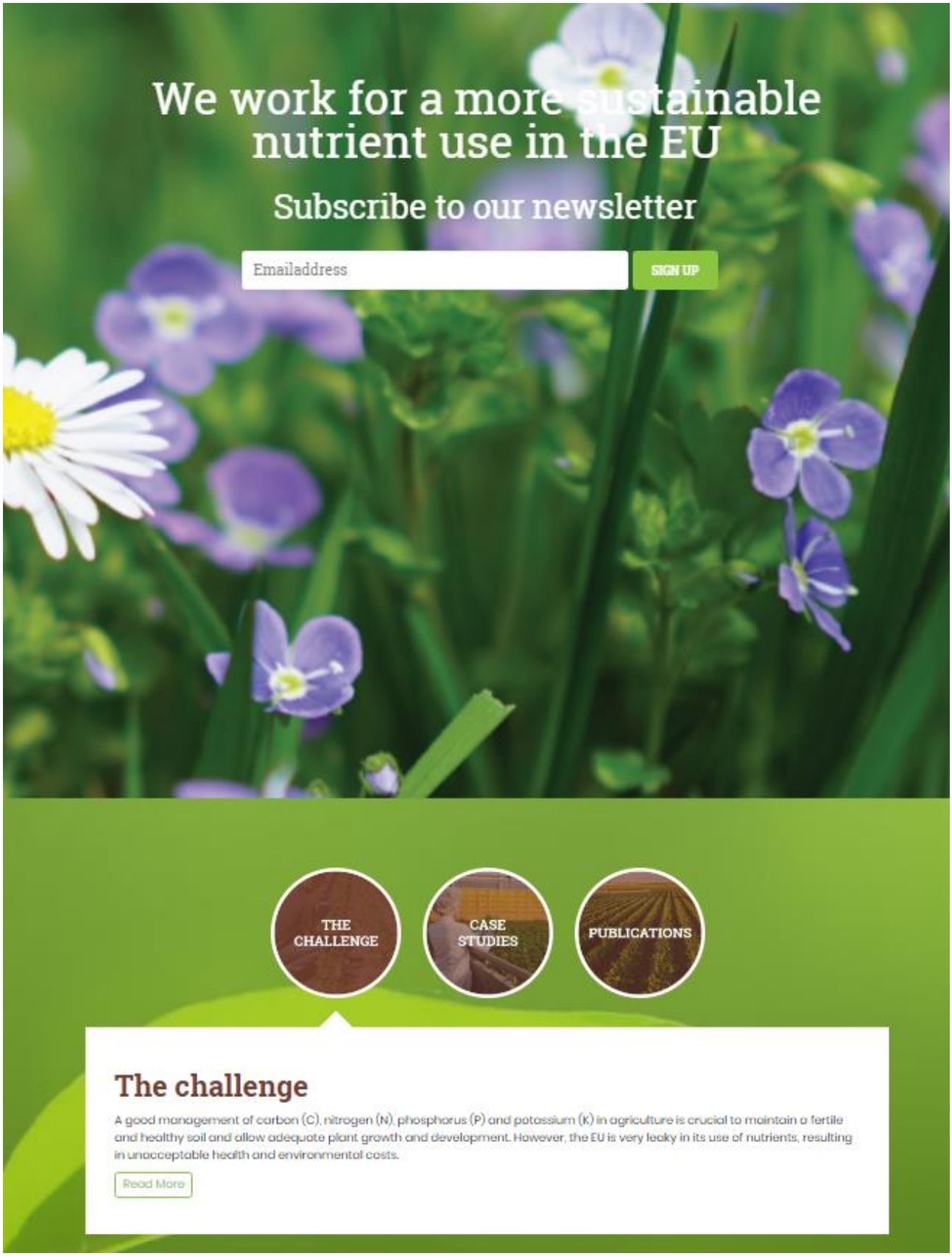
D6.3 Website and twitter set up (first and final version)

Deliverable details	
Deliverable number	D6.5
Revision number	Circular Agronomics-D6.5-E-0219-Website and twitter account set up (final version), project brochure
Author(s)	Elisabet Nadeu and Annabelle Williams
Due date	28/02/2019
Delivered date	28/02/2019
Reviewed by	
Dissemination level	Public
Contact person EC	Giuseppe La Ciura

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1. WEBSITE


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THE CHALLENGE
CASE STUDIES
PUBLICATIONS
The challenge
A good management of carbon (C), nitrogen (N), phosphorus (P) and potassium (K) in agriculture is crucial to maintain a fertile and healthy soil and allow adequate plant growth and development. However, the EU is very leaky in its use of nutrients, resulting in unacceptable health and environmental costs.
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Successful 1st European Sustainable Nutrient Initiative.

February 8, 2019

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Feb 1, 2019

Circular Agronomics @CircularAgro
Looking forward to attending the #EIPAgri Workshop in Lithuania (6 Feb) on opportunities for farm diversification and explaining more about @CircularAgro bit.ly/2WpkmG

Jan 25, 2019

Circular Agronomics @CircularAgro
Fantastic first event for the European Sustainable Nutrient Initiative yesterday #ESNI. All presentations now available bit.ly/2MvSTUq @systemic_eu @Bioref_Cluster

Jan 24, 2019

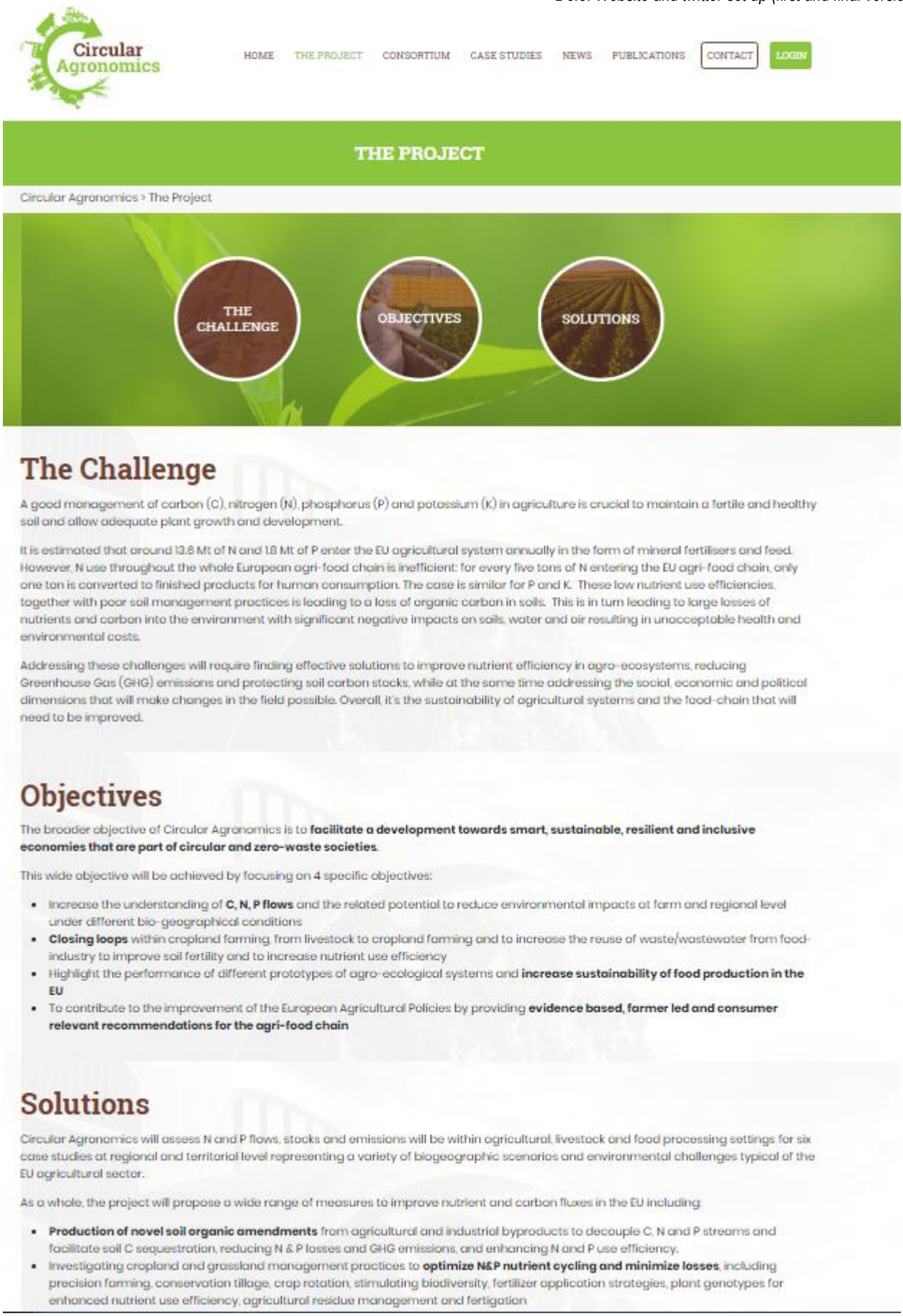
Circular Agronomics @CircularAgro
Looking forward to the first #ESNI event in Brussels next week to promote the importance

Funding Source

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THE CHALLENGE
OBJECTIVES
SOLUTIONS
The Challenge
A good management of carbon (C), nitrogen (N), phosphorus (P) and potassium (K) in agriculture is crucial to maintain a fertile and healthy soil and allow adequate plant growth and development.
It is estimated that around 13.6 Mt of N and 1.8 Mt of P enter the EU agricultural system annually in the form of mineral fertilisers and feed. However, N use throughout the whole European agri-food chain is inefficient: for every five tons of N entering the EU agri-food chain, only one ton is converted to finished products for human consumption. The case is similar for P and K. These low nutrient use efficiencies, together with poor soil management practices is leading to a loss of organic carbon in soils. This is in turn leading to large losses of nutrients and carbon into the environment with significant negative impacts on soils, water and air resulting in unacceptable health and environmental costs.
Addressing these challenges will require finding effective solutions to improve nutrient efficiency in agro-ecosystems, reducing Greenhouse Gas (GHG) emissions and protecting soil carbon stocks, while at the same time addressing the social, economic and political dimensions that will make changes in the field possible. Overall, it's the sustainability of agricultural systems and the food-chain that will need to be improved.
Objectives
The broader objective of Circular Agronomics is to facilitate a development towards smart, sustainable, resilient and inclusive economies that are part of circular and zero-waste societies.
This wide objective will be achieved by focusing on 4 specific objectives:
Increase the understanding of C, N, P flows and the related potential to reduce environmental impacts at farm and regional level under different bio-geographical conditions
Closing loops within cropland farming, from livestock to cropland farming and to increase the reuse of waste/wastewater from food-industry to improve soil fertility and to increase nutrient use efficiency
Highlight the performance of different prototypes of agro-ecological systems and increase sustainability of food production in the EU
To contribute to the improvement of the European Agricultural Policies by providing evidence based, farmer led and consumer relevant recommendations for the agri-food chain
Solutions
Circular Agronomics will assess N and P flows, stocks and emissions will be within agricultural, livestock and food processing settings for six case studies at regional and territorial level representing a variety of biogeographic scenarios and environmental challenges typical of the EU agricultural sector.
As a whole, the project will propose a wide range of measures to improve nutrient and carbon fluxes in the EU including:
Production of novel soil organic amendments from agricultural and industrial byproducts to decouple C, N and P streams and facilitate soil C sequestration, reducing N & P losses and GHG emissions, and enhancing N and P use efficiency.
Investigating cropland and grassland management practices to optimize N&P nutrient cycling and minimize losses, including precision farming, conservation tillage, crop rotation, stimulating biodiversity, fertilizer application strategies, plant genotypes for enhanced nutrient use efficiency, agricultural residue management and fertigation

Objectives

The broader objective of Circular Agronomics is to **facilitate a development towards smart, sustainable, resilient and inclusive economies that are part of circular and zero-waste societies.**

This wide objective will be achieved by focusing on 4 specific objectives:

- Increase the understanding of **C, N, P flows** and the related potential to reduce environmental impacts at farm and regional level under different bio- geographical conditions
- **Closing loops** within cropland farming, from livestock to cropland farming and to increase the reuse of waste/wastewater from food-industry to improve soil fertility and to increase nutrient use efficiency
- Highlight the performance of different prototypes of agro-ecological systems and **increase sustainability of food production in the EU**
- To contribute to the improvement of the European Agricultural Policies by providing **evidence based, farmer led and consumer relevant recommendations for the agri-food chain**

Solutions

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As a whole, the project will propose a wide range of measures to improve nutrient and carbon fluxes in the EU including:

- **Production of novel soil organic amendments** from agricultural and industrial byproducts to decouple C, N and P streams and facilitate soil C sequestration, reducing N & P losses and GHG emissions, and enhancing N and P use efficiency.
- Investigating cropland and grassland management practices to **optimize N&P nutrient cycling and minimize losses**, including precision farming, conservation tillage, crop rotation, stimulating biodiversity, fertilizer application strategies, plant genotypes for enhanced nutrient use efficiency, agricultural residue management and fertigation
- Livestock management to **minimize GHG emissions and optimize manure characteristics**, including feeding strategies and feed additives
- **Multiple manure, digestate and food waste valorization techniques for fertilizer recovery**, including N recovery via ammonia stripping with vacuum degasification, N recovery as ammonium sulfate solution, co-digestion, S/L separation, post-treatment of the liquid fraction, solar and thermal drying and acidification of solids, phytase addition to solid food waste or food wastewater to increase the soluble phosphate fraction, P depletion of food waste/wastewater and recovery as struvite
- **Food-industry wastewater treatment for recovery of C-rich compounds** (cellulose, lignin and proteins) for reuse on farms, towards the circular economy

These solutions will all be reinforced by an exhaustive environmental assessment (by means of life cycle assessment tools), exploitation plans for industrial partners, and dissemination towards different stakeholders from science, policy, industry and directly to the farmers.

The project is structured around 7 work packages:

- WP1: Plant-Soil Interactions (leads: WUR)
- WP2: Livestock emissions and residues treatment (leads: IRTA)
- WP3: Carbon and Nutrient valorization from food-waste and food-processing waste-(water) (leads: KWB)
- WP4: Social and Economic Evaluation (leads: Teagasc)
- WP5: Environmental Evaluation (leads: AREC)
- WP6: Dissemination and Exploitation (leads: RISE)
- WP7: Management (leads: IRTA)
- WP8: Ethics

Funding Source

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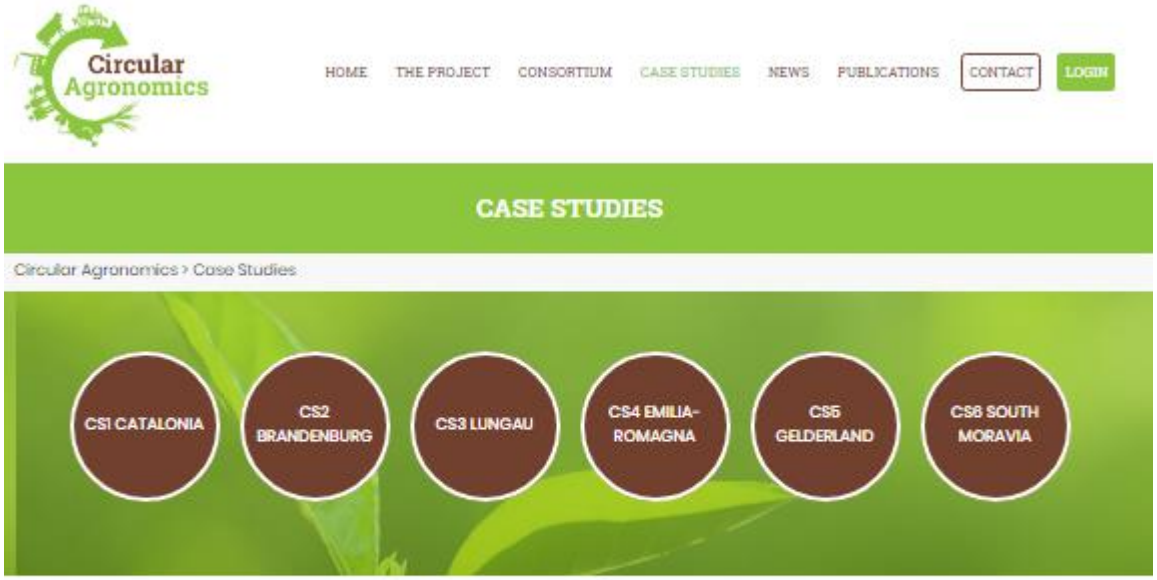
Partners | Expert Advisory Board

Partners

18 partners are involved in the consortium representing 10 different countries (8 EU Member States and 2 Non-EU: Switzerland and Kenya). The competences of all partners fully cover the entire innovation value chain and include: research institutes and foundations, planning and consulting companies, technology and process providers, end users and dissemination experts.



- **Institut de Recerca i Tecnologia Agroalimentàries**, Spain
- **KWB Kompententzzentrum Wasser Berlin Gemeinnutzige GMBH**, Germany
- **Wageningen University Research**, Netherlands
- Verein Zur Forderung Agrar-UND Stadtokologischer Projekte (**ASP**) Ev Institute Fur Agrar-UND Stadtokologische Projekte An Der Humboldt, **Germany**
- Fondazione **CRPA** Studi Ricerche, **Italy**
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- **Centre De Recerca En Economia I Desenvolupament Agroalimentari** – UPC – IRTA, **Spain**
- **Teagasc** – Agriculture And Food Development Authority, **Ireland**
- **The Rural Investment Support For Europe Foundation**, **Belgium**
- **Pondus** Verfahrenstechnik GmbH, **Germany**
- **Eastern Africa** Farmers Federation, **Kenya**
- **Soepenberg** Fertilizers BV, **Netherlands**



CASE STUDY 1 : CATALONIA (Spain)



Site description: Mediterranean biogeographic region with mild winters, warm summers and water scarcity due to low precipitation

Challenges: Increased competition for water between different users and conservation of soils that have low organic carbon content

Objective: Closing loops within cropland farming, from livestock to cropland farming and to increase the reuse of waste / wastewater from food-industry to improve soil fertility and to increase nutrient use efficiency

Selected management practices:

- Livestock: pig manure valorization (anaerobic co-digestion of pig manure solid/liquid separation, stripping and solar drying). Production of organic fertilizers)
- Cropland: long-term organic fertilization in soils (assessment of changes in soil organic carbon and phosphorus accumulation in soils)
- Mixed-farming system with ruminants (precision feeding tools) and production of fodder crops

Expected benefits:

- Reduced nutrient surplus per agricultural area and increased nutrient efficiency on a yield scaled basis
- Reduced direct emissions to air and water and reduced indirect emissions
- Increase net stabilizable carbon stocks in cropland.
- Reduction of carbon- and nutrient-rich waste

Leading partner: IRTA

CASE STUDY 2: BRANDENBURG (Germany)



Site description: sandy soils, 500 mm annual precipitation, 9.8°C mean temperature with long dry summer periods. Crops grown: cereals, oil seedrape, maize, potatoes, fodder crops, grass

Objective: Improving nitrogen efficiency at different stages of crop production

Selected management practices:

- Testing organic N-fertilizer application strategies for minimizing yield-scaled emissions
- Studying genotypic differences in mechanisms contributing to N-efficiency of plants
- Management of treated residues application, application strategies and potentials of recovered mineral fertilizers from digestates
- Experiment with 5 different biogas digestates, applied twice a year since 2011

Expected benefits: Improvements are expected in:

- Yields of grain and nitrogen content in straw
- Ammonia and nitrous oxide emissions
- Nitrate leaching
- Testing performance of recovered mineral fertilizers in comparison to original materials

Leading partner: IASP

CASE STUDY 3: LUNGAU (Austria)



Site description: Mountain areas with mean altitude of 1148m, average slopes of 22.7%, low mean annual temperatures of 5.2°C and mean annual precipitation of 720mm

Challenges: Area with low productivity, stocking rates are 1.02 LSU/ha of which 92% are cattle. Farmers aim to differentiate their products in the market to sustain themselves economically. Animals feed mostly on forage and concentrate represents only 5% of their diets. The main challenge is to establish a totally independent and closed system of local production under rough, alpine conditions.

Objective: Close nutrient cycles at dairy farms and reduce GHG emissions which are usually attributed to extensive farming systems

Selected management practices:

- Close N-P and P-Cycles at dairy farms
- Feeding strategies, gaseous emissions and manure characteristics (using a respiration chamber). These will be tested on 70 organic farms in the region.

Leading partner: AREC

CASE STUDY 6: SOUTH MORAVIA (Czech Republic)



Site description: South Moravia has area 7 085 km2 – 9 % of the area in the Czech Republic and 1 035 588 inhabitants. South Moravian territory has hottest climate in the Czech Republic. 80% of the soil is agricultural land which of is 83 % arable. Soil is very fertile and has to be irrigated at several places to produce agricultural products.

Challenges: Challenges are to considerably reduce high nutrient losses from food production and food waste and increase recycling to farms.

Objective: Demonstration of C-rich product addition to the soil. Waste products from food industry (esp. dairy industry) will be targeted. Demonstration will be practiced on wheat crops.

Selected management practices:

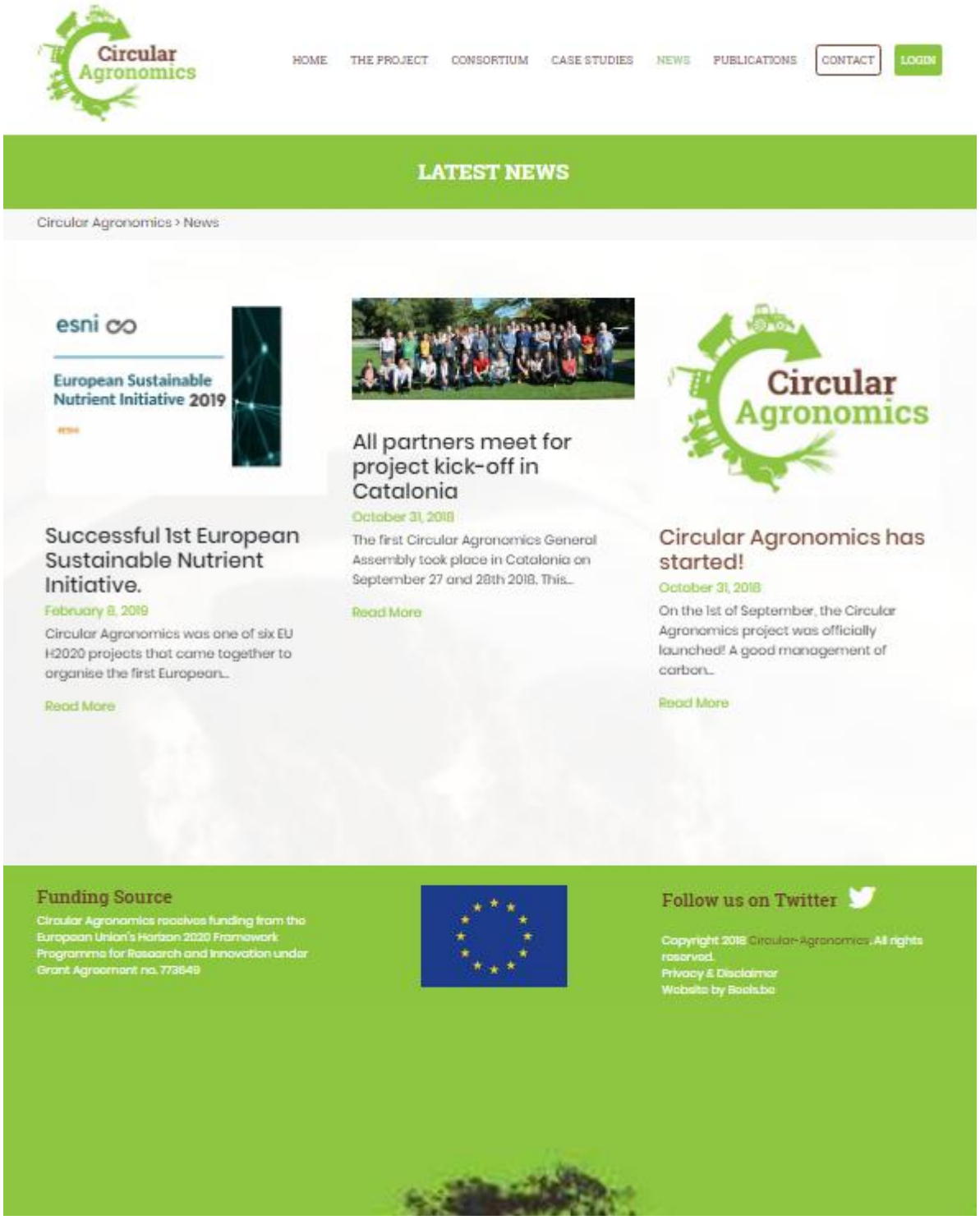
- Application of carbon rich compounds to winter wheat fields to increase soil organic carbon
- Recovery of carbon rich compounds for reuse on farms through the application of electrospun nanofibrous membranes for whey separation

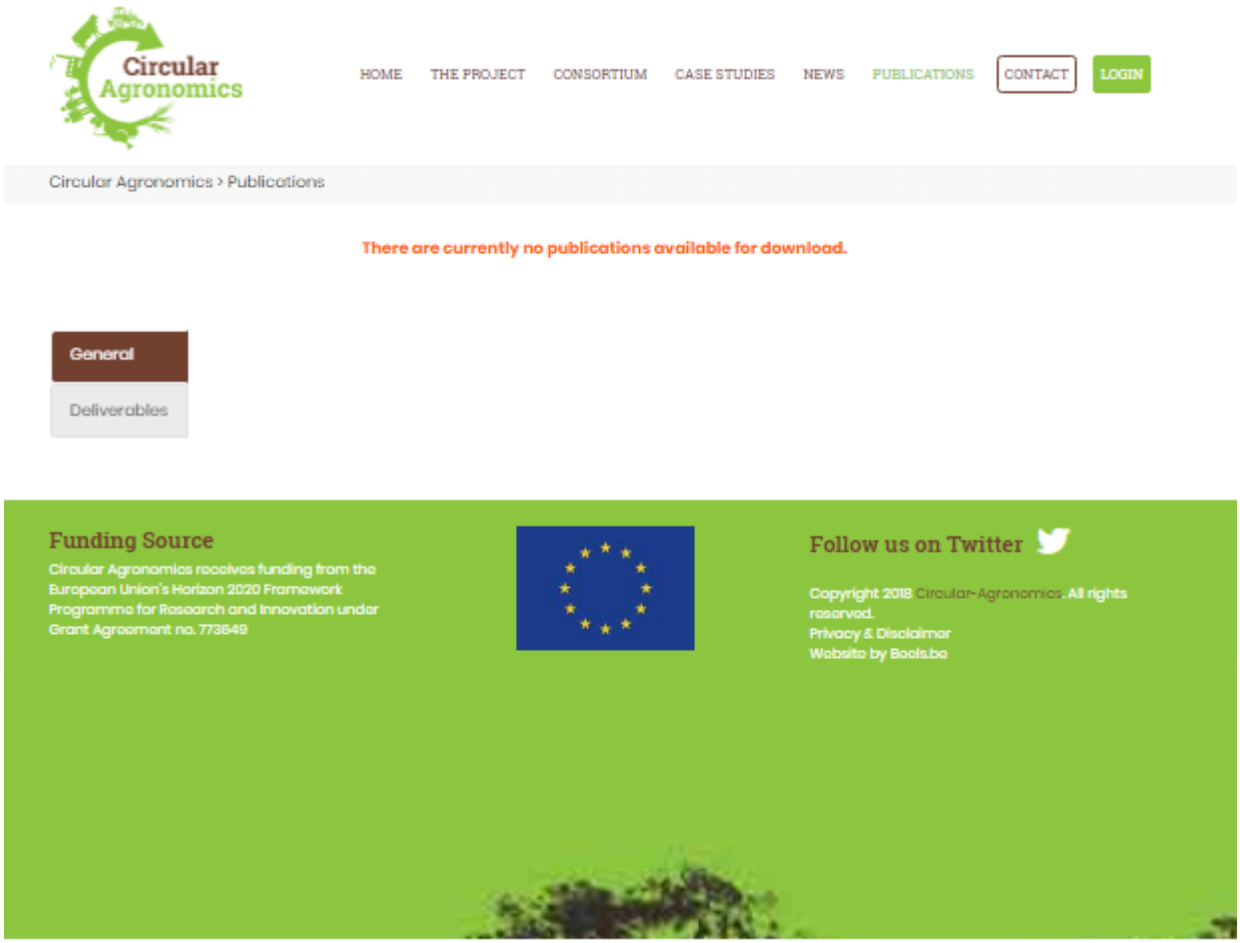
Leading partner: ASIO

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161K Tweets
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Ariana
393K Tweets

3. **PROJECT BROCHURE**

Case study sites



CATALONIA, SPAIN
Pig manure valorisation for organic fertiliser and bioenergy production, assessment of changes in soil organic carbon & phosphorus accumulations in soils, precision feeding in dairy cows & production of fodder crops.

BRANDENBURG, GERMANY
Testing organic N fertiliser application strategies, studying genotype differences in mechanisms contributing to N efficiency of plants, management of treated residue application & application strategies & the impact of gaseous emissions and manure characteristics.

LUNGAU, AUSTRIA
Closing N-P & P-Cycles at organic dairy farms (feeding strategies, gaseous emissions and manure characteristics - using a respiration chamber).

EMILIA-ROMAGNA, ITALY
Conservation tillage and cover crops, digestate treatment (microfiltration) with application via drip line fertigation.

GELDERLAND, THE NETHERLANDS
Testing plant diversity impacts on soil P and mitigating GHG emission, investigating the relationship between earthworms and P availability of plant growth, testing fertiliser ability of several novel biosolid amendments.

SOUTH MORAVIA, CZECHIA
Recovery of carbon-rich compounds from food production for use in improving carbon content of soils.

Our partners

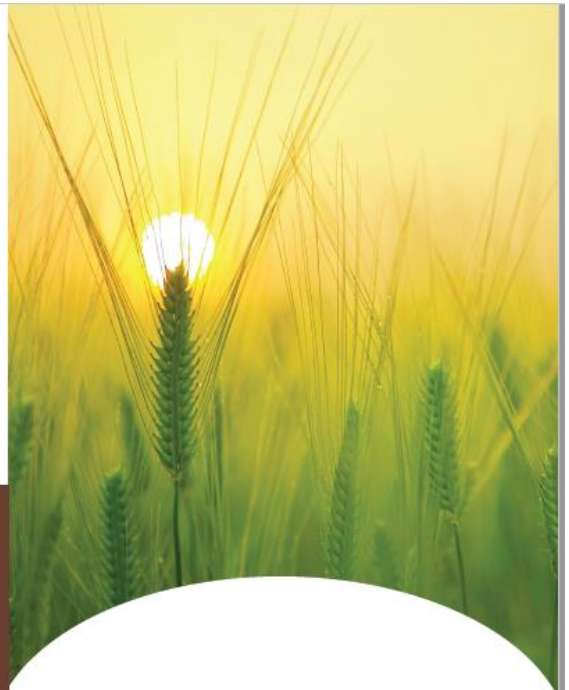
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Circular solutions for carbon and nutrient management

The challenge

Carbon, nitrogen, phosphorous and potassium are crucial in agriculture to maintain a fertile and healthy soils, and allow adequate plant growth and development. Yet, in our current system, soils are being depleted of carbon and valuable nutrients being lost, leading to the pollution of our rivers and air and contributing to GHG emissions.

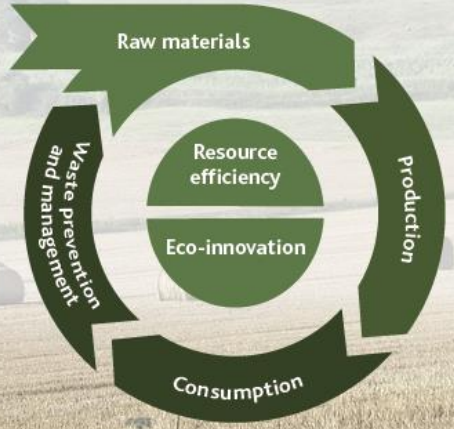
This is because nutrient use in our system is inefficient.
Over half of the nitrogen and phosphorus entering our agricultural system is coming from non-renewable sources and yet only one tonne of every five tonnes of nitrogen entering the EU agri-food chain is actually converted into food for human consumption; the story is similar for phosphorus and potassium.

In addition, poor soil management practices are leading to loss of carbon in soils which is exasperating the situation.

The solution

Circular agronomics applies the principles of the **circular economy** to agriculture.

In a circular economy, the aim is to extract the maximum value from resources (such as nutrients) whilst in use, then recover and regenerate products and materials at the end of their lifecycle (waste). Therefore, Circular Agronomics is working to find new, innovative solutions at the farm level to use nutrients more efficiently, reduce nutrient waste, and recover and re-use nutrients from biowaste.



The project

The project will investigate and test a wide range of measures to improve nutrient and carbon use in the EU, including:

- The production of novel organic soil amendments from agricultural and industrial by-products;
- The investigation of cropland and grassland management practices to optimise GHG emissions and optimise manure characteristics;
- The testing of multiple manure, digestate and food waste valorisation techniques for fertiliser recovery;
- The investigation of food industry wastewater treatment for the recovery of carbon-rich compounds.