Re-Livestock
RESILIENT FARMING SYSTEMS

Deliverable 8.10
Practice Abstracts – Batch 1

Contents

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Executive Summary

Re-Livestock is a multi-actor HORIZON EUROPE funded project aiming to evaluate and mobilize the adoption of innovative practices applied cross-scales (animal, herd, farm, sector and region) to reduce greenhouse gas emissions from livestock farming systems and increase their capacity to dealing with potential climate change impacts.

As part of the Task 8.4, targeted dissemination products and activities, Re-Livestock project must create 50 practice abstracts to be delivered in two batches. Practice abstracts are short summaries of activities, research result, recommendation, innovation or practical recommendations that the project is delivering. Practice abstracts are later published in EIP Agri platform and eventually appear in the EIP Agri newsletters.

The objective of current deliverable is to deliver the first batch of practice abstracts containing 16 documents mostly describing early-stage activities of the project.

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1. Introduction

Re-Livestock project

Re-Livestock is a multi-actor HORIZON EUROPE funded project aiming to evaluate and mobilize the adoption of innovative practices applied cross-scales (animal, herd, farm, sector and region) to reduce greenhouse gas emissions from livestock farming systems and increase their capacity to dealing with potential climate change impacts. To reach our aim, Re-Livestock have brought together the excellence scientific expertise in Europe and Australia and across disciplines, including co-innovation, animal feeding, breeding, welfare, farm management, environmental and socio-economic assessment and policy analysis, to develop novel and scientifically supported integrated approaches specific for different dairy, beef and pig systems and geographic regions in the context of climate change. Strong collaboration with industry stakeholders to identify the innovations and to co-design the validation will ensure relevance and maximise the adoption of best practices. National groups of farmers (case studies) and 'stakeholder forums' together with a 'European multi-actor platform' will allow for an engaged co-design of transition pathways whilst 'learning from innovation networks' will allow for the testing and sharing of latest innovative solutions. A 'community of practice' will extend the multi-actor approach to a broad range of stakeholders.

Re-Livestock work packages

To meet the objectives pf the project, Re-livestock is organized in 9 different work packages (WP). Each WP has different objectives and focus, however WPs must work together to meet the final goal of the project (Figure 1).

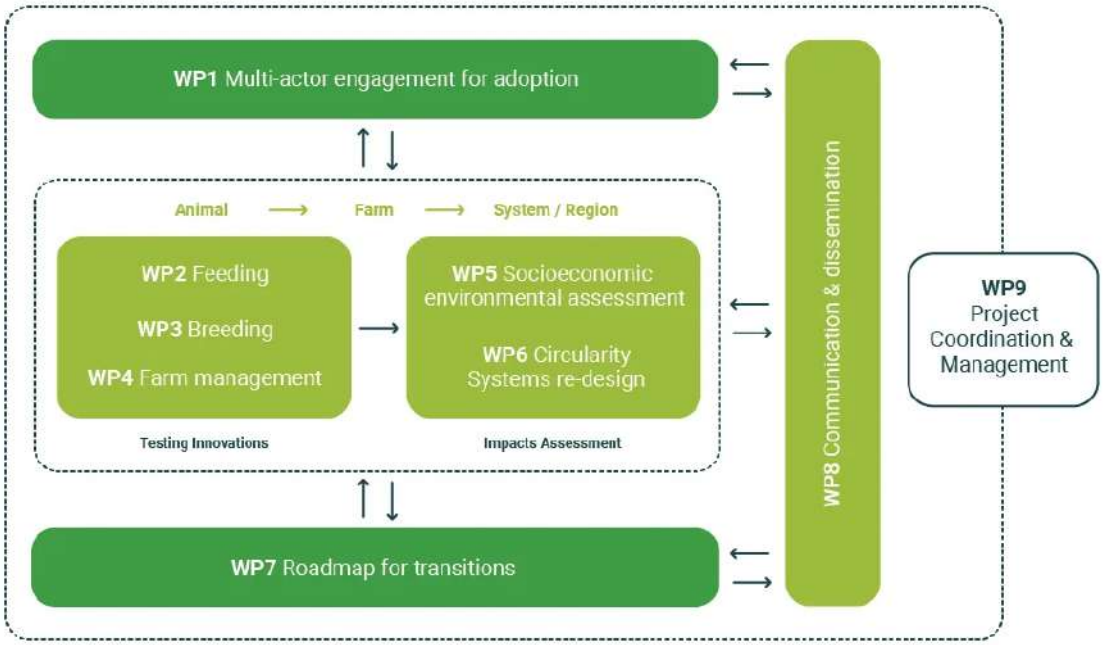

Figure 1 – Work package structure and interaction within Re-Livestock project

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Re-Livestock proposes a holistic approach based on the 'Re-Concept', by Re-Framing climate change action in livestock systems through:

WP1 – Re-Understanding and mobilising adoption through multi-actor engagement: WP1 will build and support local stakeholder forums to guide and support the co- innovation processes of the project and ensure that the voices of all key stakeholders.

WP2 – Re-Feeding livestock for resilience: recognizes the potential to mitigate livestock emissions by making greater use of feed materials with low C footprint and resilient-focused diets.

WP3 – Re-Breeding livestock for resilience: defines traits at animal level for mitigation of and adaptation to climate change. Mitigation traits will focus on CH_4 and CO_2 emissions of dairy and beef cattle, whereas adaptation traits will focus on changes in (re)production performance of cattle and pigs related to weather conditions.

WP4 – Re-Managing at farm level for livestock resilience: will assess a broad set of farm level management alternatives including housing, manure management, agroforestry systems to mitigate heat stress conditions in intensive cattle and pigs systems, improving system efficiency and reducing emission intensity.

WP5 – Re-Assessment of livestock farm systems: focuses on the assessment of farm level environmental and economic performance, as well as indicators for animal welfare and public goods. Utilizing a range of advanced tools, and with the further development of methods to quantify C sequestration; model and real farm systems will be assessed to develop baseline and future scenarios.

WP6 – Re-Design of circular systems: will create a model suite (Re-Model) to define possible redesigns of livestock production systems within a circular bio-economy.

WP7 – Re-Map a roadmap for transition: adopts a systemic approach to describe potential adaptation and mitigation scenarios for the European livestock farming systems. The WP identifies farmers adoption of the innovations and defines action-based priorities and processes to mobilise the transition towards the Green Deal and Farm2Fork objectives.

WP8 - Communication, dissemination and capacity building

WP9 - Project Coordination and Management

2. Communication, dissemination and capacity building

The WP8 will extend the expected impacts of Re-Livestock beyond the project lifespan and help support the uptake of project results and outputs by the relevant sectors by supporting the creation of a community of practice with WP1. Activities will increase awareness, knowledge and insight on Re-Livestock research and results targeting scientists, cattle and pig breeding organisations, feed and feed additive companies, animal health professionals, farm

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managers and advisors, farmers, policy makers, food industry, consumers and society in general.

To reach this goal WP8 will:

- develop and update a detailed dissemination and communication plan,
- disseminate and communicate the project's results outside of the consortium,
- interact with EIP-AGRI platform and other on-going H2020, HEurope and international projects,
- outreach to farming, advisory and policy groups through adapted dissemination materials and activities and
- deliver training on the utilisation of innovative practices and knowledge developed to early career scientists and professionals.

3. Practice Abstracts – Batch 1

As part of the Task 8.4. Targeted dissemination products and activities, Re-Livestock project must create 50 practice abstracts to be delivered in two batches. Practice abstracts are short summaries of activities, research result, recommendation, innovation or practical recommendations that the project is delivering. Practice abstracts are later published in EIP Agri platform and eventually appear in the EIP Agri newsletters.

The target public for the Practice Abstracts are the different stakeholders of the project, namely: farmers, advisors and technicians, researchers, staff from companies, regulators and administrations, and policy makers. The texts should be as simple and interesting as possible for all end-users, targeting broad type of people.

The current deliverable will deliver the first batch of practice abstracts containing 16 documents mostly describing early stage activities of the project. Table 1 shows a summary of the practice abstracts included in this Batch 1. Attached to this deliverable is the Annex 1 which contains the practice abstracts in an Excel file as required by EIP Agri (file name, D8.10_Practice abstract batch 1_Annex 1_template_eip.xlsx)

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Table 1 – Practice abstracts included in Batch 1

Number	Title
1	Re-Livestock, an interdisciplinary project to Re-design livestock farming systems
2	Training facilitators for case studies to facilitate engagement with stakeholders
3	Adapting sustainability assessment tool for data collection in Re-Livestock
4	Case study on 'Using by-products in dairy farming' - Spain
5	Case study on 'Testing by-products as low C feeds for beef cattle' - UK
6	Feeding pigs with local legumes
7	Can multispecies grassland help fight climate change?
8	Animal breeding as effective methane mitigation strategy
9	Breeding as tool to adapt for climate change. The cattle options
10	Metabolomics to identify markers of heat stress tolerance in different pigs breed
11	Manure management to reduce emissions and optimize nutrient recycling
12	Housing strategies to help dealing with climate change in dairy cattle
13	Practices to promote C sequestration and nutrient recycling in agroforestry systems
14	Analysing environmental benefits of livestock innovations
15	Assessment of farm animal welfare under climate change scenarios
16	Modelling future European food systems

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Practice abstract 1 - Re-Livestock, an interdisciplinary project to Re-design livestock farming systems

Author
David Yañez-Ruiz, Consejo Superior de Investigaciones Cientificas (CSIC), Spain
WP9: Project Coordination and Management

Despite the extensive research of farming practices to enhance mitigation and adaptation to climate change, livestock farming systems continue to move on unsustainable trajectories through a focus on "highly tangible, but essentially weak, leverage points" caused by several **technical and adoption-related limitations**. There are, however, numerous **opportunities** to increase livestock farming resilience through better knowledge on:

i) C footprint of feed materials and alternative sources (i.e. by-products),
ii) efficacy of mitigation feed additives across different production systems,
iii) how climate change is affecting growth and utilization of grasslands,
iv) the impact of integrating mitigation and adaptation goals in livestock breeding programs across a range of breeds,
v) the impact of combining different farm level practices with support of modern technologies in different production systems,
vi) the impact of the innovations across scales/levels (temporal, spatial and organizational), and
vii) how to operationalize the transition to a more resilient livestock sector.

The ambitious studies in Re-Livestock will serve to address and exploit these opportunities through:

- Regional-specific integrated assessment of mitigation and adaptation practices
- Refining existing tools and models for a holistic evaluation of current and future livestock systems
- Assessing livestock system resilience
- Determining the role of livestock in supporting circularity

To address the above tasks a big interdisciplinary consortium with 37 partners from 14 countries (Figure 1) has been developed that includes **farmers associations** (AEANI, PFLA, PROVAC**),** livestock **feeding companies** (DSM, AGRI), **seed company** (BH), **breeding companies** (CRV, PIC, ANAS), **precision livestock company** (PCH), **advisors** (L&F, CONSULAI, BH), who will work closely with fourteen universities (UNIBO, UPV, UREAD, WU, SLU, AU, UCD, UNIPI, QUB, AERES, UEX, BOKU, UQ) and nine applied research and technology institutes (CSIC, WR, SRUC, FIBL, PIK, MVARC, ORC, AGROS, IRIAF) leading the field in stakeholders engagement, extension technology transfer, feeding and nutrition, animal breeding, GHG measurements, climate change scenarios development, grassland management and agroforestry, on-farm sustainability assessment, ecosystem services, animal welfare and precision livestock farming. Re-Livestock will also benefit from expertise in knowledge exchange, communication and outreach through communications and training agencies (CONSULAI, CIHEAM-IAMZ)

Figure 1. Re-Livestock consortium

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Practice abstract 2 - Training facilitators for case studies to facilitate engagement with stakeholders

Author
James Kinsella, University College Dublin (UCD), Ireland
WP1: Re-Understanding and mobilising adoption through multi-actor engagement

Re-Livestock delivered a two-day training course for case study facilitators in Madrid on 17-18th January 2023. This was an in-person event that allowed the facilitators an opportunity to get to know each other at this early of the project and to begin the process of building a team who will work together and support each other over the five years of the Re-Livestock project (Figure 1).

The training was attended by fourteen case study facilitators, co-ordinated by UCD and contributed to by other partners. The training course guided facilitators from what they already knew about facilitating multi-actor co-innovation processes to a shared and common understanding of the process. Most facilitators had limited experience of this role while others had a lot of experience to share. Given the broad range of case study actors, topics and locations the training also addressed the need to consider diversity in their role, with inputs by FiBL on gender mainstreaming and UCD on sharing knowledge.

Training was highly participatory, and trainees engaged in the discussions and small group tasks to share experiences and move collectively towards shared understandings. Important contributions by the trainees were captured throughout the session by using flipcharts while the participants worked together in an open, trusting, and constructive environment which they had agreed to from the outset (Figures 2 and 3).

Overall, the training was highly valued by the participants as captured in the end-of-training evaluation with an overall 90% 'good' or 'very good' rating.

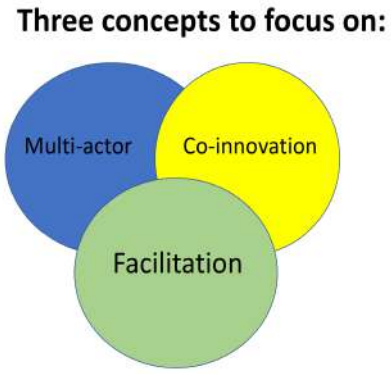

Figure 1. The three concepts addressed in the training course.

Figure 2. Participants practicing multi-actor co-innovation.

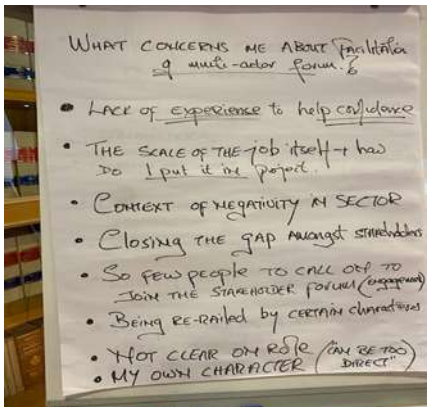

Figure 3. Using flipcharts to capture shared points.

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Practice abstract 3 - Adapting sustainability assessment tool for data collection in Re-Livestock - UK

Authors

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Nicholas Davison, University of Reading (UREAD), UK
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WP1: Re-Understanding and mobilising adoption through multi-actor engagement

Central to the Re-Livestock project are the local stakeholder forums and associated innovative case studies, which guide and support the co-innovation processes throughout the project. Farms within the case studies are demonstrating innovations in practice, including innovations in feeding, breeding, and management. To describe, characterize and monitor the performance of the mitigation and adaptation potential of case study farms, as well as provide specific data for other tasks within the project an existing sustainability assessment tool, the OCIS Public Goods Tool (PG Tool) was modified. An excel workbook, it measures sustainability across 11 spurs by collecting data on farm inputs and outputs, as well as farm practices. The modified Re-Livestock Tool keeps the same framework (Figure 1).

We had 1:1 interviews with case study facilitators to identify essential new questions to capture their innovations, adapting questions to make them relevant to the case studies, as well as identifying any questions that were not relevant and could be filtered out for their specific case study. Work package leaders and the gender task force were consulted to identify essential questions and identify which information to feed back to them (Figure 2). The tool was then adapted accordingly and transformed to an on-line tool (www.mvarc.eu/tools/dev/re-livestock_tool), available in all languages of the case studies (Figure 3).

The tool is designed for researchers to assess the public goods provision of different innovative livestock farms across Europe. Potentially it could also be used by farmers as a self-assessment, and it will be available, open access, beyond the end of the project.

Figure 1. Radar diagram showing scores for the 11 public goods spurs of the PG Tool.

Figure 3. Screenshot of landing page for the on-line Re-Livestock Tool.

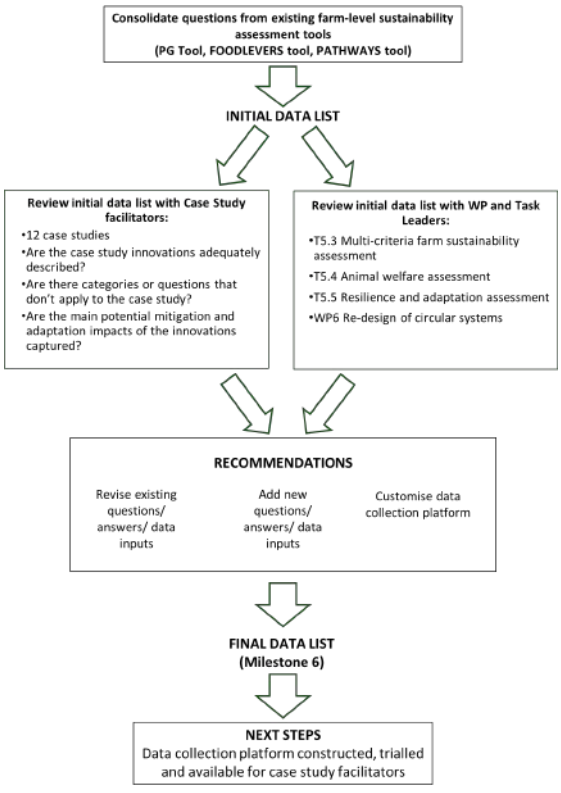

Figure 2. Overview of methodology for identifying final data requirements for data collection framework.

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Practice abstract 4 - Case study on 'Using by-products in dairy farming' - Spain

Authors
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David Yañez-Ruiz, Consejo Superior de Investigaciones Cientificas (CSIC), Spain
WP1: Re-Understanding and mobilising adoption through multi-actor engagement

Dehesa is an agro-silvo-pastoral system and cultural landscape of southern-central Spain and Portugal where holm oak forests and grazing cattle, goats, sheep, and the Iberic pig all function together. It is usually considered "marginal areas" in Spain due to the limited agricultural potential, lack of local industry, and weather inclemency (Figure 1). Due to pasture scarcity, Dehesa dairy producers usually import conventional ingredients such as corn, especially during drought. In recent years, these ingredients have experienced high and variable prices, leading to the need to find alternative resources.

The inclusion of by-products in dairy diets as a cost-efficient alternative is gaining popularity. One example is the surplus form the intensive horticulture that has been shown successful when is preserved as silage (Figure 1). However, there are issues and obstacles to solve to fully implementing by-products in dairy cows' diets—for example, seasonality and quality. There are not always guarantees that a chosen by-product will be available year-round; even if it is, its quality will not be affected. Furthermore, if a chosen by-product is only sometimes available, it will require long planning, like buying larger quantities, processing, and storage. This raises other questions for dairy farmers. Will cow diets change drastically if a by-product must be substituted due to seasonality? Will the quality hurt dairy cattle and milk quality? Working with Dehesa's dairy producers, including some that have implemented the use of by-products regularly, will help answer these and further questions and elaborate a plan where selected by-products can be safely incorporated into dairy cows' diets efficiently for producers, consumers, and the environment (Figure 2).

Figure 1. Dairy farm in dehesa ecosystem and cherry tomatoes surplus stored before making silage

Figure 2. Discussion within Stakeholder forum

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Practice abstract 5 - Case study on 'Testing by-products as low C feeds for beef cattle' - UK

Authors
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Christos Christodoulou, University of Reading (UREAD), UK
WP2: Re-Feeding livestock for resilience

Utilising agro-industrial by-products contribute to circular bioeconomy, offering advantages in terms of sustainability, cost-effectiveness, and nutritional value. Brewers' spent grains (BSG) is a by-product of the brewing process, and has commendable nutritional value, in terms of protein and fibre content. Beyond its nutritional efficacy, feeding locally-produced BSG addresses the dual challenges of waste management in the brewing industry and the negative environmental impact associated with importing conventional protein feeds.

The collaboration between breweries and livestock farmers in establishing efficient supply chains for BSG represents a shift toward a more sustainable agro-industrial framework. For this reason, an animal trial was conducted at the University of Reading which compares the effect of different dietary protein sources (such as soyabean, beans, and BSG) on feed efficiency and methane emissions in indoor beef production systems, while simultaneously been compared to a 100% pasture-fed beef system. Why is this important? Conducting this study will explore the potential of replacing imported protein sources, such as soyabean meal, with local alternatives without affecting (or potentially even improving) the growth rates of beef cattle and reducing their methane emissions? It aligns with the principles of a circular economy, seeking to optimise the use of resources and minimise agricultural. Furthermore, understanding how various diets and production systems influence beef production and methane emissions is crucial for assessing the overall environmental sustainability of beef production. Results from this study will be made available during 2024.

Figure 1. Holstein × Angus crossbred steers in the barn.

Figure 2. Methane emissions were recorded using the GreenFeed automated head chamber system.

Figure 3. Steers within each group were selected to undergo additional digestibility and methane assessments.

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Practice abstract 6 - Feeding pigs with local legumes

Authors
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WP2: Re-Feeding livestock for resilience

One of the activities programmed in the Re-livestock project is searching for strategies for reducing soya as the main protein source in pig diets. The dependence on soya imports of European livestock feeding industry is very high and this generates an elevated carbon footprint associated to livestock feeding. One possible solution is the replacement of soya for other protein sources produced closer to pig farms. Local legumes -well adapted to local and diverse climatic conditions- could be a good source of protein for pigs when included in the diet appropriately complemented.

Two set of studies are being carried out in Spain and Poland, respectively, including local legumes for feeding cosmopolitan and local breeds of pigs. In Spain, farm experiments are using the fraction discarded for human consumption of lentils, peas and chickpeas to replace (totally or partially) soya in the diet of growing cosmopolitan pigs (Figure 1). Lab experiments including growing cosmopolitan and Iberian pigs will be performed for a deeper look into the legume treatments showing better performance at farm level. In Poland, faba beans (Figure 2) and lupins (Figure 3) will be used to include in the diet of local Puławska pigs during the grower and finisher periods. Growth, feed efficiency and meat quality results generated in these experiments could be very valuable for promoting the use of legume for inclusion in pig diets. This will contribute to reduce the carbon footprint associated to pig feeding with the additional benefit of enriching the quality of soils.

Figure 1. Lentils, chickpeas and peas.

Figure 2. Faba beans plant and seed.

Figure 3. Lupins plant and seed.

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Practice abstract 7 - Can multispecies grassland help fight climate change?

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WP2: Re-Feeding livestock for resilience

Grassland can contain a wide range of plant species in addition to grass, which may bring a number of benefits. Some, such as clover, can fix atmospheric nitrogen and reduce the need for expensive inorganic fertilisers derived from fossil fuels. Many have deeper roots than grass, making them more drought resistant and also better at storing carbon in the soil. Diversity of plant species increases the diversity of other forms of life.

Could multispecies grasslands also reduce the amount of methane produced by from grazing cattle and sheep, thereby helping the fight against climate change? This question will be addressed in three experiments planned for summer 2024. In Switzerland, methane emissions will be measured in cattle grazing natural pastures with different plant species composition. Meanwhile, in Northern Ireland and Scotland, we will measure methane production from dairy cows grazing grass, grass/clover or multispecies pastures (Figure 1).

Across the three experiments, we will also check for effects on pasture growth and quality, milk yield and composition, cattle growth, aspects of animal behaviour, and markers of biodiversity, to give a rounded picture of the value of diverse, multispecies grassland.

Figure 1. Pasture approximately 6 weeks after sowing. Left: pure perennial ryegrass. Right: multispecies mixture showing the emergence of white and red clover, chicory and plantain. (SRUC, Barony Campus, Scotland).

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Practice abstract 8 - Animal breeding as effective methane mitigation strategy

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WP3: Re-Breeding livestock for resilience

Ruminants emit methane, which is one of the strongest greenhouse gases responsible for climate change. Strategies to reduce the amount of methane from ruminants are currently heavily searched. Animal breeding is one of the most promising climate change mitigation strategies. To identify animals with a genetic predisposition for lower methane emission, breeding values for methane emission as selection tools for farmers and breeding organisations need to be estimated. To achieve accurate and most reliable breeding values large number of individual animals need to be measured for the trait of interest. Methane emission is a novel trait in animal breeding, routine recording schemes are just currently being developed and implemented in some countries.

In order to increase the accuracy of breeding values for methane, an international effort is undertaken by collating methane recordings of individual cattle in Australia, Poland, Spain and The Netherlands. Altogether, this will build an initial data pool of around 12,000 cattle recorded for methane emission. This is one of the largest methane data pools available as to date. Methane emission can be measured with different techniques. In Australia, the GreenFeed system is used to record methane emission on pasture (Figure 1). In Spain and The Netherlands, a so called sniffer system is used, where a gas sensor is installed in the automated milking system and methane is measured during milking of the cow (Figure 2). The work in Re-Livestock will combine all methane measurement measured with different devices with state of the art methods to estimate breeding values (genomic selection) to provide farmers with the most reliable breeding values for methane emission as selection tools on farm.

Figure 1. The GreenFeed system (C-Lock Inc.) is used to measure individual methane emission on pasture in Australia. The methane emission is collected while the animal is eating concentrate. (Credit: Sam Clark)

Figure 2. the sniffer methane sensor (Carltech B.V.) connected to the automated milking system on commercial farms in The Netherlands. In The Netherlands 100 commercial farms are equipped with sniffers for routine methane recording (Credit: Anouk van Breukelen)

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Practice abstract 9 - Breeding as tool to adapt for climate change. The cattle options

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WP3: Re-Breeding livestock for resilience

Climate change threatens the sustainability of cattle production in many regions. Changing the genetic potential of animals to improve resilience to changing environments dominated by high temperatures can be accomplished with breeding management. However, identifying what animals are tolerant to heat is not obvious. Re-Livestock project, is assessing tolerance to heat stress using a combination of traditional indicators such as production and physiological measures together with innovative measures such as mid infrared (MIR) spectra, behaviour of animals, and metabolomic profiles in cattle.

In order to investigate the biological mechanisms behind heat tolerance experiments with feed lot calves from a local beef breed (Avileña-Negra, ANI) and Holstein (HOL) lactating cows are being carried out. Participant animals were identified as tolerant or susceptible to heat by measuring respiration rate in the first heat waves of July 2023. Subsequently, blood samples of animals in each group were obtained during that summer and then under comfort temperatures in autumn.

First analyses evaluating the heat stress impact on the productivity of ANI cattle in Spain showed only a moderate effect of high temperatures on weaning weights and reproductive parameters. For the physiological measure of RR, ANI calves showed similar values to the Holstein cows under mild heat stress conditions. These results would indicate a higher tolerance to heat for the local beef breed compared to the highly selected HOL dairy cows. MIR spectra obtained from milk recording in summer vs. other periods showed potential to discriminate both the heat stress periods and the tolerant (cows that showed higher RR) vs. susceptible (showing lower RR) dairy cows.

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Practice abstract 10 - Metabolomics to identify markers of heat stress tolerance in different pig breeds.

Author
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WP3: Re-Breeding livestock for resilience

Heat stressing conditions are expected to be much more frequent in the coming years in many parts of the world. Heat stress in pigs is not beneficial at all: it causes production losses and increased production costs. For example, pigs that are not tolerant reduce feed intake and therefore worsen growth rate and sows reduce reproduction performances. Therefore, we need to breed more resilient pigs, that can better cope with this problem. But how we can do that? To proceed with this aim, we first need to answer another key question: What are the phenotypes that we can explore to understand the genetic components of heat stress tolerance in the pigs? To reply to this challenging question, Re-Livestock is going to dissect the very basic biological processes underlying heat stress response in pigs by analysing hundreds of molecular phenotypes, the metabolites, that are present in the blood. For many metabolites, their level in the blood is genetically determined. The metabolites are analysed used an analytical approach, called metabolomics. Re-Livestock is applying, for the first time, high throughput metabolomic analyses in a large pig population, including different breeds and lines. The obtained information is used to identify novel markers linked to the genetic background that explain the physiological adaptation of the animals to the heat conditions of the animals. The experimental designs that Re-Livestock has set up have already demonstrated the feasibility of this approach and promising results have already been obtained. Based on that, we can say that metabolomics can provide useful information to re-design the breeding of the pigs to increase tolerance to heat stress conditions (Figure 1).

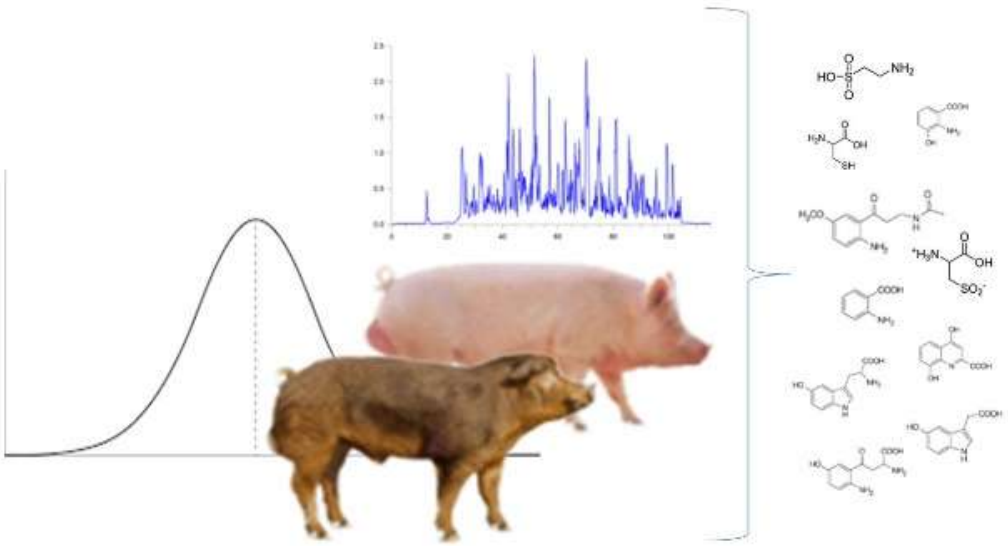

Figure 1. Metabolomics can help to identify tolerant pigs to heat stress.

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Practice abstract 11 - Manure management to reduce emissions and optimize nutrient recycling

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WP4: Re-Managing at farm level for livestock resilience

Manure is a key source of nutrients for agriculture. By suing manure as fertilizer, the impact of producing and using synthetic fertilizers in agriculture might be reduced. This practice also contributes to improve soil quality. Nutrient losses through gaseous emissions, leaching and runoff result not only on pollution to the environment but on the loss of fertilizing potential, reducing the circularity on livestock production.

In the Re-Livestock project, different alternatives aimed to optimize nutrient conservation in manure will be tested. Management options for solid and liquid manures will be considered. Different composting strategies will be evaluated for nutrient fluxes using beef cattle manure. The main aim is to promote nitrogen conservation and to assess the potential carbon sequestration in soils when applied to agricultural land. Solid-liquid separation combined with composting of the solid fraction will be also evaluated using pig slurry. Promising results are being obtained also when acidifying pig slurry to mitigate nitrogen losses through ammonia volatilization (Figure 1).

Figure 1. Measuring ammonia emissions from manure treated with different acid levels.

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Practice abstract 12 - Housing strategies to help dealing with climate change in dairy cattle

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WP4: Re-Managing at farm level for livestock resilience

Title in original language (Spanish): Estrategias de alojamiento para hacer frente al cambio climático en explotaciones comerciales y de cría de ganado vacuno lechero

Rising temperatures due to climate change significantly threaten animal welfare in dairy cattle production systems. The resulting heat stress not only endangers animal health but also may affect the productive performance of these farms. To address this challenge, the Re-Livestock Project offers practical strategies to enhance animal welfare and support the farmers by improving daily farm management. In the project context, the optimisation of animal showers and using shading to reduce heat stress will be tested.

As for showering the animals, the project focuses on determining their optimal number and frequency to mitigate stress without compromising other crucial aspects of animal welfare, such as ensuring the animals' adequate rest. Regarding the use of shadows, the Re-Livestock Project applies precision livestock farming tools to assess animal behaviour patterns linked with available shade and climatic conditions, thus determining the most effective use of shade on rearing farms. The outcomes of these trials will substantially contribute to improving animal welfare and sustaining productive performance in commercial and rearing dairy farms.

In all, by providing farmers with practical tools, the project empowers them to optimise their processes and adapt their practices, thereby ensuring the well-being of the animals and the long-term viability of the dairy cattle production sector.

El aumento de las temperaturas debido al cambio climático amenaza considerablemente el bienestar animal en sistemas de producción de vacuno de leche. El estrés térmico resultante no sólo pone en peligro la salud de los animales, sino que también puede afectar al rendimiento productivo de estas explotaciones. Para hacer frente a este reto, el proyecto Re-Livestock ofrece estrategias prácticas para aumentar el bienestar animal y apoyar a los ganaderos mejorando la gestión diaria de sus explotaciones. En el contexto del proyecto, se pondrá a prueba la optimización de las duchas para animales y el uso de sombreado para reducir el estrés térmico.

En cuanto a la ducha de los animales, el proyecto se centra en determinar su número y frecuencia óptimos para mitigar el estrés sin comprometer otros aspectos cruciales del bienestar animal, como garantizar el descanso adecuado de los animales. En cuanto al uso de sombras, el proyecto Re-Livestock aplica herramientas de ganadería de precisión para evaluar los patrones de comportamiento animal vinculados al la disponiblidad de sombra y las condiciones climáticas, determinando así el uso más eficaz de la sombra en las granjas de recría. Los resultados de estos ensayos contribuirán sustancialmente a mejorar el bienestar de los animales y a mantener el rendimiento productivo en las explotaciones lecheras comerciales y de recría.

En definitiva, al proporcionar a los ganaderos herramientas prácticas, el proyecto les capacita para optimizar sus procesos y adaptar sus prácticas, garantizando así el bienestar de los animales y la viabilidad a largo plazo del sector de

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Practice abstract 13 - Practices to promote C sequestration and nutrient recycling in agroforestry systems

Author
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WP4: Re-Managing at farm level for livestock resilience

Researchers from the project Re-Livestock cooperate with farmers in Spain, Portugal, UK, and Denmark to investigate novel agroforestry practices. The vision is to promote animal welfare, carbon sequestration, and nutrient cycling in outdoor livestock systems while supporting farm feed supply.

A range of new agroforestry and grassland practices will be evaluated:

In Spain, sheep herds will test rotational grazing and pastures enriched with legumes to increase pasture production and quality in silvopastures.

With a similar objective, farmers in Portugal will test new shade tolerant pasture mixtures in existing stone pine (Pinus pinea) silvopastures. These practices are also expected to benefit tree growth through improved nutrient status of the soil.

In UK, grass-fed dairy cows will get access to woodland in the summer to reduce heat stress and thereby improve animal welfare and productivity.

In Denmark, outdoor pigs will forage willow (Salix sp.) in two animal densities to test the effects on pig growth, feed efficiency, and soil nutrient load and distribution (Figure 1).

Across borders and experiments, diverse forage samples from the agroforestry systems, e.g. willow and pasture mixtures will be analysed to explore their nutritional value.

Figure 1. Foraging willow, Denmark.

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Practice abstract 14 - Analysing environmental benefits of livestock innovations

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WP5: Re-Assessment of livestock farm systems

Food production contributes to about one third of a person's carbon footprints. The production of meat is particularly relevant. Cattle produce methane while digesting feed, which is a strong climate gas. In addition, manure management and feed production largely contribute to the carbon footprint of meat.

To mitigate climate impacts innovations are needed on both the supply side, such as changes in the production, as well as on demand side, such as reducing meat consumption and food waste. In this project, we will analyse how innovations in meat production can lead to a reduced carbon footprint. We calculate environmental impacts across the value chain of livestock systems with the method of "life cycle assessment". In a first step, we address methodological challenges of this method such as how to assess carbon stored on pastures or how to account for the fast degradation of methane in the atmosphere compared to carbon. In a second step, we analyse the environmental performance of different innovations tested in the experiments of Re-Livestock. Tested solutions will span from improved feeds, not competing with food (Figure 1), to improved breeds with lower methane emissions and to improved farm management which lower emissions. Results will show the environmental benefits of innovations and highlight potential trade-offs between food production, farmers income and different environment impacts, such as climate change or overfertilization of surface waters.

The text in this stage could follow the following logic:
- What is the problem
- What are we going to do to solve (or contribute to solve) it?
- What results / outcomes are expected?
- What could be the added value/benefit and use of these results/outcomes and who will be the users?

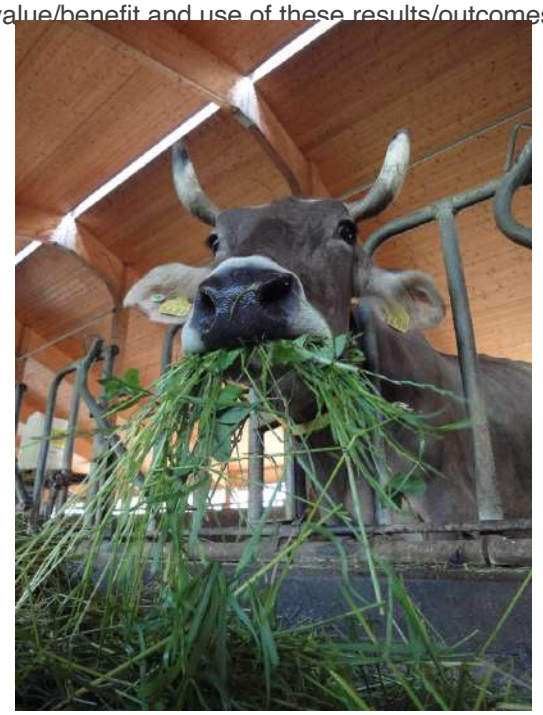

Figure 1. Feed no food: A cow eating grass (Credit: Thomas Alföldi)

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Practice abstract 15 - Assessment of farm animal welfare under climate change scenarios

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WP5: Re-Assessment of livestock farm systems

The relationship between climate change and livestock farming is complex and affects animals differently in different systems. E.g., intensive dairy cows with high metabolic-heat production will likely be at risk of heat stress at lower temperatures compared to cows in a low-input system. However, a grazing cow may not have access to shade/cooling and be at greater risk of diseases associated with direct solar radiation (Figure 1). In the face of increasingly challenging weather patterns, understanding these dynamics is crucial for developing strategies that promote good animal welfare alongside sustainable and resilient food production (Figure 2). This task aims to evaluate the impact of climate change on animal welfare by identifying hazards and risks in a range of farming systems across various climatic conditions. It will cover different regions, evaluating them against modelled scenarios of climate change. Specifically, we plan to collect data from five European weather stations, each representing a distinct climate zone (such as 'hot and dry' and ' cold and wet'), and to model climate change scenarios until 2100. We will analyse how projected climatological changes relate to animal welfare, using relevant welfare indicators from existing literature. We will then explore strategies to mitigate impacts including assessing the innovative practices in feeding, breeding, management and systems that are being tested in the Re-Livestock project for their ability to address identified risks to welfare. Furthermore, we will delve into the role of Precision Livestock Farming (PLF) in climate mitigation, exploring its potential to minimize climate-related animal welfare hazards and consequences.

Figure 1. Dairy cows seeking the shade of a tree on a hot day. (Credit: Lindsay Whistance)

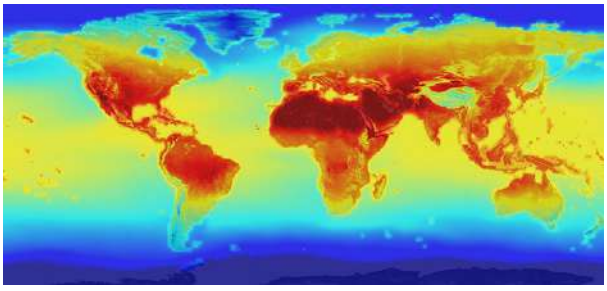

Figure 2. NASA's predictions (2015) of how global temperature might change under different emissions scenarios. (Credit: NASA)

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Practice abstract 16 - Modelling future European food systems

Author

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Susanne Rolinski, Potsdam-Institut Fur Klimafolgenforschung (PIK), Germany
WP6: Re-Assessment of livestock farm systems

How future European food should look like to be able to provide healthy and sustainable diet under climate change? What and how many animals should be kept and what they should be fed with? What crops should we grow? Which are the most effective agro-ecological and technological strategies within the livestock sector to mitigate and adapt to climate change? These are all relevant questions that we aim to tackle in WP6. We will do so by combining a suit of computer models. The Lund-Potsdam-Jena managed land model (LPjmL) will provide data on potential future crop yields in Europe under multiple climate change scenarios (Figure 1). The Circular Food Systems model (CiFoS) (Figure 2) will use this crop data to model what crops we should grow and what animals we should keep for being able to produce a healthy and sustainable diet under the different climate change scenarios, and mitigation and adaptation strategies. The Livestock Spatial Allocation model (LSAM) model will then use CiFoS outputs to assess the impacts environmental impacts at more local levels (e.g., landscapes). Finally, based on the modelling outcomes, we will develop a serious game that will be played with European stakeholders. The aim is to let them design scenarios for future European food systems based on their visions and interests, and explore via a game setting the feasibilities of such scenarios and the compromises that need to be made in order to make them possible.

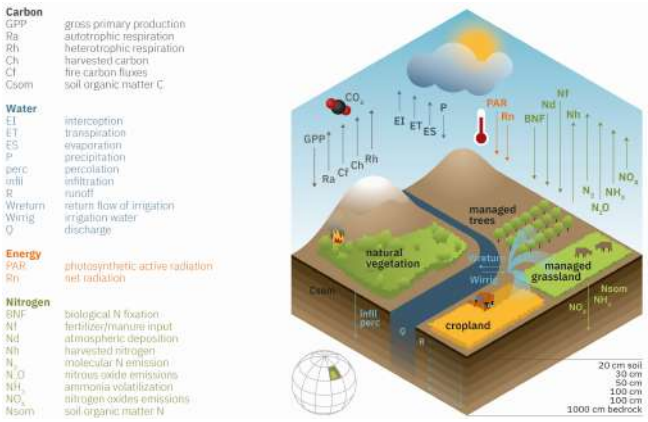

Figure 1. Graphical scheme of the LPJmL model. Each spatial unit can be covered by cropland, grassland, natural vegetation and biomass plantations. Cropland and grassland activities can be subject to different management (e.g. irrigation, fertilization, crop choice and settings of sowing dates). Each setting results in consistent stocks and flows of carbon (black), water (blue), energy (red) and nitrogen (green).

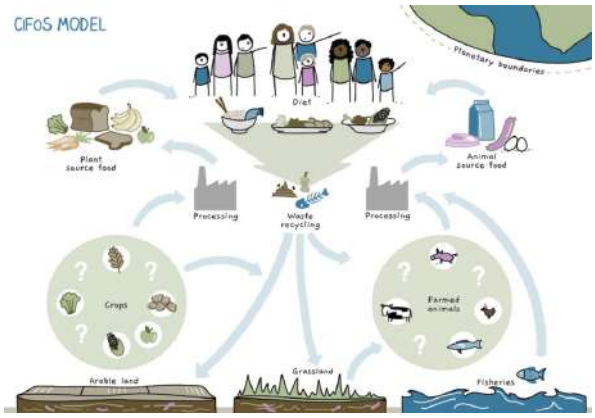

Figure 2. Graphical representation of the CiFoS model. The CiFoS model ingeniously ties multiple modules together (land, crops, fisheries, food and feed processing, waste recycling, livestock, human nutrition) to provide a healthy diet with the minimum environmental impact. CiFoS is unique because it embraces circularity principles due to its model structure: residual streams (by-products, manure, food waste) from one process become the input of another to estimate the environmental impact of healthy diets at a food systems level.

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