RESILIENT DAIRY LANDSCAPES

Newsletter 2021

The Resilient Dairy Landscapes project, funded by the Global Food Security Programme, sought to explore the trade-offs between farmers' livelihoods, the natural environment and the stable supply of reasonably priced dairy products, to find better ways of working in the face of unpredictable future societal, environmental and climate change.

Due to delays caused by the COVID pandemic, the project has been extended to December 2022 to enable additional data collection and analysis on biodiversity and animal health, alongside the application of findings on ecosystem markets, extending Landscape Enterprise Networks across the UK and internationally, and developing a UK Farm Soil Carbon Code.

This newsletter describes key findings to date around ecosystem markets, and how these markets are delivering ecosystem services and improvements in animal health.

Ecosystem markets

The project evaluated the operation of Landscape Enterprise Networks (LENs) in Cumbria and East Anglia, initiated the first LENs in SW Scotland and supported the extension of LENs into Europe. This included interviews with farmers and investors to evaluate how the scheme operated on the ground, and natural and veterinary science to evaluate whether the scheme delivered public goods and the benefits expected by investors.

What are Landscape Enterprise Networks?

LENs is a model for delivering private investment in ecosystem services, enabling financial flows through 'green commerce', avoiding loading landscapes with unnecessary debt based financial instruments. To do this, it identifies and prioritises landscape challenges and assets and identifies corporate actors who are affected by these challenges or that depend upon or benefit from these ecosystem assets e.g., water quality, biodiversity, flood risk mitigation and carbon sequestration. LENs provides a framework for multiple organisations to co-procure landscape outcomes from land managers (the 'suppliers' of ecosystem services) in a landscape where they have shared interests, paying famers a fair price for the services they provide whilst reducing risks or procuring benefits for the investors.

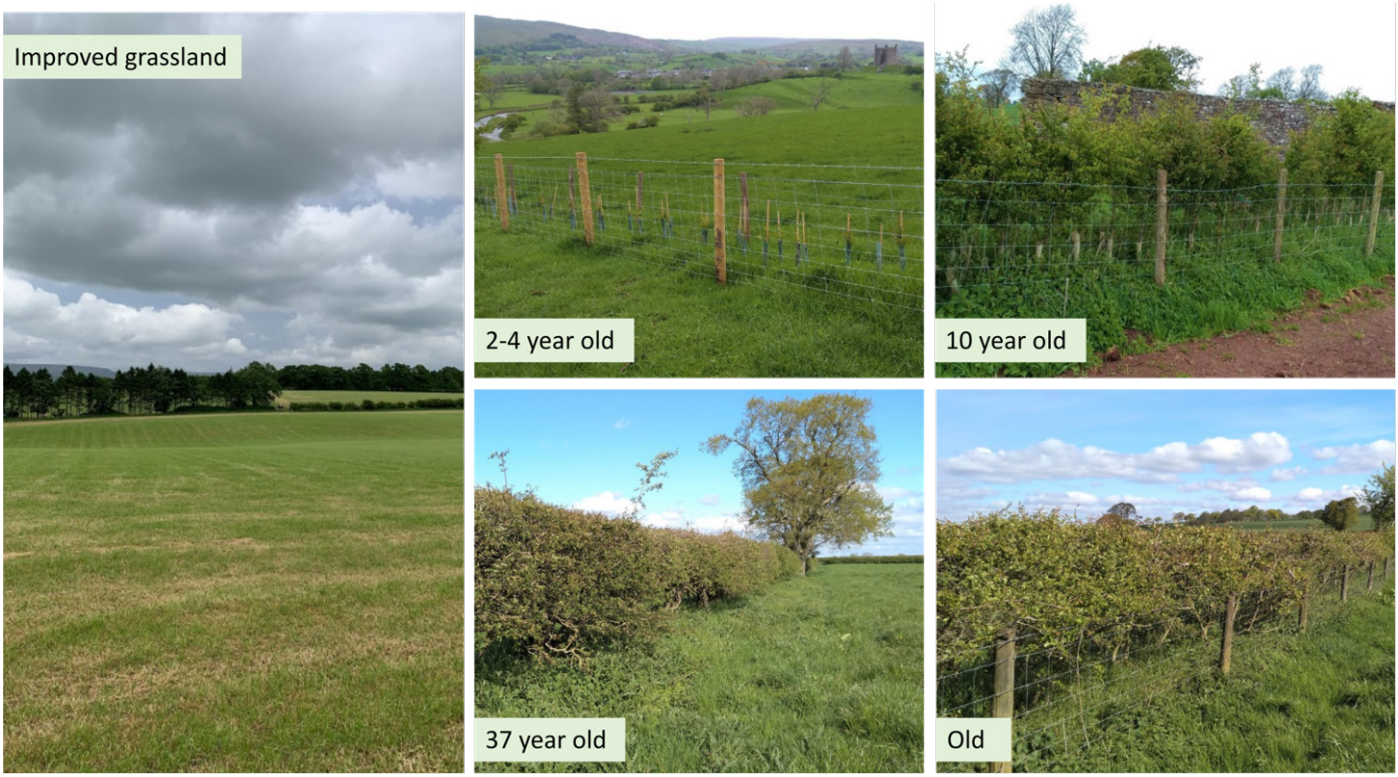
The following key messages emerged from project's social science and legal research on LENs:

- Ecosystem markets have the potential to fund significant reductions in Greenhouse Gases from the dairy production systems and the wider land use sector
- All dairy farmers supplying Nestle in the UK have been implementing on-farm interventions via LENs for more than 3 years and aim to reduce the carbon footprint of their fresh milk supply by 50% by 2025
- Farmers interviewed for our research said they prefer private investment via LENs to publicly funded alternatives (agri-environment schemes)
- Phase 1 of the East Anglia LENs programme was oversubscribed by farmers by 40%

- New agri-environment schemes need to be designed to explicitly to leverage and blend with private investment, increasing overall funding available to regenerative agriculture and conservation, whilst targeting public funding to locations and services the market is unlikely to pay for
- Integration of LENs with national carbon markets has the potential to increase funding for regenerative agriculture and conservation whilst reducing trade-offs across multiple habitats and services
- The creation of new ecosystem markets, for example for farm soil carbon, has the potential to buffer predicted reductions in public funding for agriculture post-2024, making farm businesses in food supply chains more resilient
- Research from this project is being used to develop a UK Farm Soil Carbon Code that will protect the interests of farmers, project developers and investors, and incentivise a large-scale transition to regenerative agricultural practices that are good for the climate and biodiversity
- The long-term functioning of a LENs with multiple participating demand and supply side actors will need a robust legal framework, this must be sensitive to the unique features of LENs as a collaborative management tool. Crucially, unlocking this potential will involve ecosystem service clients from outside the food sector, for instance water companies, housing developers, and businesses involved in, or dependent on transport and energy infrastructur
- The key bottleneck in new ecosystem markets is not a lack of capital; instead it is a disconnect between potential customers of ecosystem functions and those who can deliver value. The landscape need commerce, not finance; or put another way, it needs customers not moneylenders
- LENs is a place-based approach to co-producing ecosystem markets with local land managers, ensuring that land management change is responsive to local ecological, economic, and cultural conditions. It is also required for proper integration of multifunctionality into intervention design, since most ecosystem outcome values, and all land management systems, are fundamentally dependent. Work is ongoing to explore how LENs can catalyse wider social and economic regeneration.

Ecosystem services

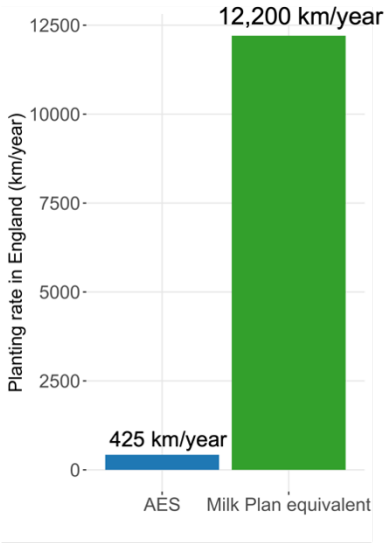
The Nestlé-First Milk Landscape Enterprise Network (LENs) in Cumbria aims to secure the long-term supply of milk to its processing plants by paying farmers a premium if they carry out specific practices that aim to protect water bodies, improve biodiversity, reduce greenhouse gas emissions, antibiotic use and on-farm plastics, and increase soil carbon. The project's natural science team has been evaluating the impact of the scheme by assessing the delivery of public goods from LENs via empirical data collection and modelling of interventions funded under the scheme.



Hedges used in the research. All new hedges planted over historical hedgerow boundaries

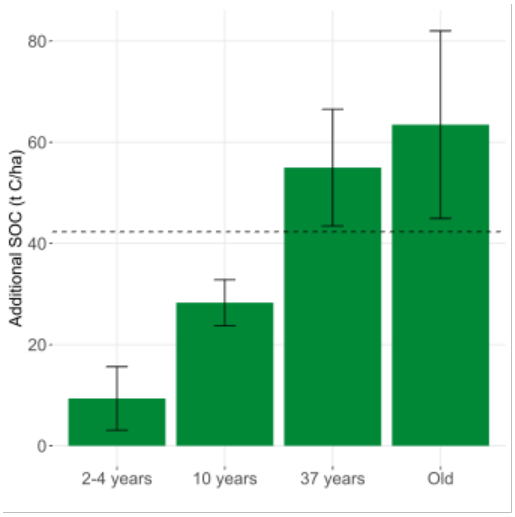
To date the results show:

- Hedgerow planting within the Nestle-First Milk scheme occurred at double the rate of public agri-environment schemes (AES) in Cumbria; 3.2 km yr-1 compared to 1.7 km yr-1. These higher rates can be related largely to the simplified evaluation process offered by the scheme compared to AES, as well as the reduced number of options and the flexibility in their physical implementation on the farm, which allowed farmers to complement their established practices
- At current AES rates, it would take over 200 years to achieve the Committee on Climate Change goal of increasing hedgerow length by 40%. Upscaling Milk Plan's planting rates across England, it would take just 16 years to reach this goal. Based on our carbon data, we estimate that if this goal can be reached, this would correspond to an additional 7.9 Mt of atmospheric CO2 being stored in soil beneath hedgerows, offsetting 4.73% of total agricultural CO2 emissions each year.



Hedgerow planting rate under the Nestle-FirstMilk LENs (Milk Plan) versus the publicly funded agri-environmental scheme

- We determined the soil organic carbon (SOC) in the top 50 cm of soil under hedges of different age ranges on dairy farms in the Eden Valley, Cumbria, England. We found that hedgerows stored on average 42.3 t C ha-1 more SOC than adjacent improved pastures. We also showed that the SOC stock increased with hedgerow age, and were therefore able to calculate the SOC sequestration rate associated with planting hedges in agricultural landscapes, which was estimated at ~1.5 t C ha−1



*Soil Organic Carbon under hedges of different ages. *SOC stock signifi-cantly higher than adjacent field*

- We have also investigated the impact of hedgerow age on biodiversity, specifically birds, insects and bats, using novel technology to record their sounds. We found that more birds were associated with the older hedges. We are in the process of evaluating the role of hedgerows in flood alleviation using data on hydrological conductivity and infiltration rates
- Improved management of grasslands to increase carbon stocks could help mitigate agricultural greenhouse gas emissions by:
  a. Reducing soil disturbance
  b. Returning organic matter to the fields
  c. Increasing grass species diversity
  d. Avoiding set/continuous grazing regimes
  e. Ensuring soil testing is carried out every 3-5 years to monitor the progress of the soil and adjust management accordingly

Finally, the project sought to understand if the implementation of on-farm interventions under the Nestle-FirstMilk LENs in Cumbria affects prevalence and incidence of vector borne diseases in grazing cattle:

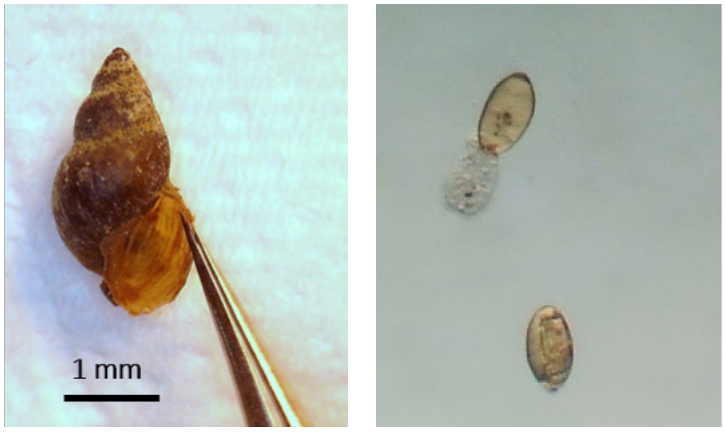
- A prioritised list of vector-borne diseases affecting cattle in the UK was compiled using published and grey literature. The diseases identified included: summer mastitis, liver fluke, Schmallenberg, Babesia (redwater fever), nuisance flies, Moraxella bovis associated keratoconjunctivitis, Anaplasma (pasture or tickborne fever) *(Table 1)*

Table 1: *Prioritised list of infectious diseases with an environmental component*

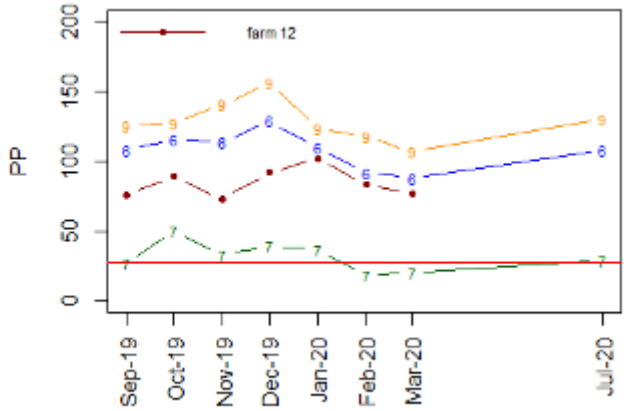
Disease	Vector	Measures that might affect prevalence
Summer Mastitis	Head fly Hydrotea irritans	More trees/hedges provide shelter for flies
Fluke	Galba truncatula	Buffer water bodies - reduce contact with host, trees - reduce host habitat
Gut and Lung Worms (Ostertagia etc)	none	Unlikely to be affected by hedges/water course fencing
Bluetongue	Culicoides spp	More trees/hedges provide shelter for flies
Schmallenberg	Culicoides obsoletus and C. dewulfi	More trees/hedges provide shelter for insects.
Babesia (redwater)	Ticks (Ixodes ricinus)	Permanent pasture
Nuisance flies	Hornfly (Haematobia irritans)	More trees/hedges provide shelter for flies
Moraxella bovis, keratoconjunctivitis (pink eye)	Face fly (Musca autumnalis)	More trees/hedges provide shelter for flies
Anaplasma (pasture fever/tick-borne fever)	Ticks (Ixodes ricinus)	Permanent pasture
Lungworm	none	Unlikely to be affected by hedges/water course fencing
Environmental mastitis (strep uberis, e. coli)	none	Fencing watercourses may reduce contamination with E. coli
Coxiella burnetii	ticks (partly)	
Giardia	none	Fencing off water course could reduce risk of zoonotic transmission
Cryptosporidium	none	Fencing off water course could reduce risk of zoonotic transmission
Warble flies	Warble flies hypoderma spp.	Eradicated from UK

TB	badger	Increase badger habitats or access or making area more attractive to badgers
Johne's	none	
Leptospira Hardjo	none	Probably none (apart from could spread farm to farm via shared watercourse)
Other lepto ser-ovars	rats	Anything that encourages rats

- A face-to-face questionnaire was used to obtain information about 12 farms in the scheme, including the most common vector-borne/environmentally associated diseases. All were dairy farms but most also had sheep and/or beef cows. Farms had a grazing area of between 64-400 ha, all had watercourses and woodland, and all but one had hedges. Interventions chosen by these farmers were walls, hedges (planting/gapping up), tree planting, and fencing waterways. The most common vector-borne/environmentally associated diseases identified were liver fluke (8/12), summer mastitis (7/12) and lungworm (6/12). Milk samples showed that 11 out of 12 farms had high levels of antibodies to liver fluke in their herds.



Left: *Dwarf pond snail, Galba truncatula;* ***Right:*** *Fluke eggs hatching to produce miracidium*



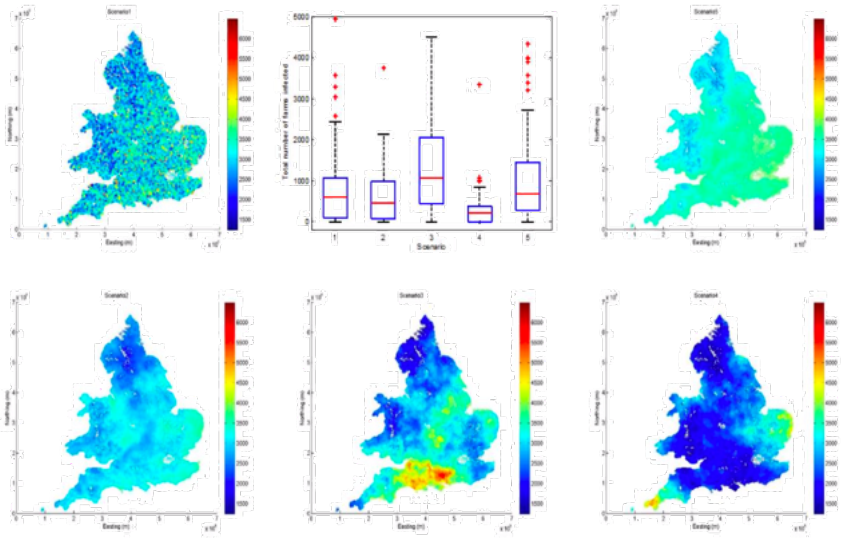
Bulk milk samples showing medium to high antibody levels to liver fluke on 11 farms

- Surveys were conducted on the distribution of Galba truncatula, the dwarf pond snail, known to be the principal vector of liver fluke. The data suggest that snail numbers are significantly lower in areas close to waterways which have been fenced off as part of the AES and were significantly less likely to be infected with the parasite compared to adjacent pasture which had not been fenced. In contrast, there were more snails in unfenced sites and they were more likely to be infected.

- The presence of livestock can “alter” potential snail habitats by trampling (creates “open mud”) and grazing (reduces shading from vegetation), leading to more algae, which in turn leads to more snails. Fencing off waterbodies has the potential to reduce liver fluke transmission in dairy herds.

Disease	2019		2020	
	Unfenced	**Fenced**	**Unfenced**	**Fenced**
No. of sites	28	20	37	18
% of sites colonised	54%	45%	59%	39%
Mean no. of snails per site	**4 ±7**	**2 ±3**	**8 ±12**	**3 ±4**
% infected with liver fluke	17%	0%	5%	0%

- Surveys of *Hydrotea irritans*, the principal vector of summer mastitis were conducted, and data obtained on incidence of summer mastitis in heifers and dry cows, grazed in fields with newly planted hedgerows, mature hedgerows or no hedgerows. The data is being analysed.
- Although hedgerow and tree planting could create breeding sites for Culicoides midges (the vector of bluetongue disease), our model showed changes in midge numbers after planting were unlikely to affect national spread of the disease



Modelled spread of bluetongue disease with and without hedgerow and tree planting

- A stochastic mathematical model describing the full liver fluke life cycle has been completed and is being validated using field data. This this is the first full model of the liver fluke life cycle, including all the free living stages and the snail intermediate host to be fully parameterised. The model will be used to assess how interventions that affect snail numbers and infection pressure on pasture affect prevalence of infection in cattle.

Find out more...

Visit *www.resilientdairylandscapes.com* or contact Professor Mark Reed: *mark.reed@sruc.ac.uk*