



# LIGHTHOUSE FARMS

READY TO MEET THE  
CHALLENGES OF 2050

*An earlier version of this article was written by Prof Rogier Schulte, Chair of Farming Systems Ecology (WUR), for the Irish Farmer's Journal Summer 2020 Agri Business report:  
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Hic sunt dracones

2020 was always meant to be the year of change. The year of 20:20 vision. The year in focus for the original Food Harvest 2020 strategy. And the year that the Paris climate agreement would come into force. A year of change it is indeed, but for reasons that none of us could have foreseen: 2020 has become the year of Covid-19. Overnight, farming and the food industry in every corner of the world find themselves at the heart of 'essential services'. Governments rush to borrow trillions against historically low interest rates, the price of oil spikes down into negative territory.

As a global community, we have never been here before. In our search for a future for our planet, we suddenly find ourselves at the edge of our map, the edge of the world as we know it. "*Hic sunt dracones*" is what the early cartographers wrote on the fringes of their

maps: here be dragons. This brave new world needs new solutions to old challenges: how can we sustain the essential service of food production within the resources of our planet, in such a way that it can absorb and bounce back from shocks, be they biological, financial, or climate shocks?

The vast majority of farmers that I have worked with over the last 20 years are proud custodians of the countryside but are grappling with the competing demands for environmental and economic sustainability. For these farmers, how can we circumnavigate today's dragons and chart a path towards a future that is sustainable in the widest sense of the word? At the Farming System Ecology group of Wageningen University and Research, we set sail to explore the world in search of lighthouse farms: farms in the 'new reality' that are already operating as if they are in the year 2050, that have somehow escaped the pragmatic constraints that most farmers find themselves in, and that have found new ways to make sustainability the engine, rather than the constraint, for profitability.

We found them where we least expected them, where we weren't necessarily looking. Beside a busy motorway in the Netherlands. In the deserted inlands of Spain. In the middle of urban Havana. And in the moonlike landscapes of Northern Ethiopia. Sometimes they stand out, visually, in the landscape, while others blend in, like any other farm. Across the continents, we have brought eleven of the finest exemplars together in our Global Network of Lighthouse Farms.

## Welcome to Latvia

Last year, we made our second visit to our lighthouse farm in Latvia, AS Ziedi JP. Driving the unpaved road, the forest opens up to large fields and a collection of large industrially sized buildings. Not quite the arcadia where you'd take your family on a camping trip, but inside these buildings, the Pilvere family have redefined what we know as circular agriculture: by cleverly combining a thousand cows, six

## Bringing future farms to life

The Global Network of Lighthouse Farms is an initiative of **Wageningen University & Research (WUR)**, the world leader in agricultural and environmental research and education.

We are the **Farming Systems Ecology group** at WUR, and focus on the radical redesign of farming systems around the world, using natural processes as our starting point. By radical, we mean: starting with a blank sheet of paper and co-designing – with the farmers – the future we want. From there we work backwards: what do we need to do now, in order to get there by 2030?

To deliver on this, we specialise in the modelling of multifunctional farming systems. Our **FarmDesign** model and our **Interactive Landscape Lab** allow farmers, policy makers and other stakeholders to discuss what-if scenarios, using interactive holograms of the farm layout: if we change the crop rotation, if we change the animal management, if we invest in machinery, then what is the impact on income? On greenhouse gas emissions? On labour requirements? On the nutritional value of the farm produce? Powerful optimisation algorithms allow the farmers to find those farm configurations that meet their expectations *and* the expectations of those around them.



*Dr Annemiek Pas Schrijver, coordinator of the lighthouse network, and Ms Lizzy Freed demonstrating the holographic landscape at the climate-smart conference in Indonesia last year.*

anaerobic digesters, two industrial generators and dozens of fish tanks, the farm produces milk, meat, electricity, fish fillets and caviar. What is the main product, and what is the by-product? Economically, this is a caviar farm. From an energy perspective, this farm is a power station, powered by the heat from the regenerator that runs on methane belched by the dairy cows, that happens to produce food on the side. In terms of biomass, this is a dairy farm with a diversity of profitable end-products. This lighthouse has redefined the concept of circularity: it has moved beyond the concept of “recycling by-products”; in fact, it makes the distinction between “main product” and “by-product” irrelevant.

## Redefining sustainability

Circularity, however, is just one of the many dimensions of sustainability. Circular agriculture, climate-smart agriculture, nature-inclusive farming, agro-ecology, regenerative agriculture, conservation agriculture, and community supported agriculture. These approaches all use the same ingredients, but the recipes are different because they are based on the environmental and societal contexts that the farms find themselves in. Irish agriculture is shaped by ruminants, so it is no surprise that the climate dimension takes centre stage in the national discussions on sustainability. Nor is it surprising that Dutch agriculture, with its large manure surplus, focusses on circularity. Or that the focus further South, in the Mediterranean region threatened by land degradation, is on regenerative agriculture. We have carefully brought together our lighthouse farms, so that each radically redefines at least one of these approaches to sustainability.

## Ympäristöystävällisimpänä

As we turn into the yard of Knehtilän cereal farm in Palopuro, southern Finland, our host Kari fills his car with biogas that is produced on the farm, using surprisingly accessible

technology: ordinary silage pits filled with green manure, in a process known as dry anaerobic digestion. This produces not only methane for motor fuel, it also reduces the volume of the green manure, concentrating its nutrient value. This allows farmer Markus to apply the nutrients to those soils that are most deficient, rather than ploughing in the green manure in situ. The result: more cereals, more biofuel. The Knehtilän farm has found a way to overcome the old dilemma of food-biofuel competition, and in the process redefined the meaning of the word *ympäristöystävällisimpänä* (“most environmentally friendly”).



*Kari fills his car with biogas extracted from his silage pit in the middle of the Finnish winter.*

## Strip-cropping

In the Netherlands, the ERF farm is redefining the meaning of ‘nature-inclusive farming’ by growing their crops, the same crops that they have always grown, in narrow strips rather than fields. Why would they do this? Seven years of research show that the mixing of crops slows

the outbreaks of pests and diseases, as these struggle to ‘find’ their target crops between the strips. At the same time, as the variety of crops ensures that there is biomass on the field at all times, strip-cropping allows the natural enemies of pests to move in faster from adjacent crops.

### A future for livestock farming

Where do animals fit into our quest for a sustainable future? Here, our exploration has brought us to one of the countries where the role of livestock is at the heart of the national debate future farming: Ireland. With more ruminants than people, and an absence of heavy industry, Ireland’s national greenhouse gas profile is dominated by methane emissions from bovine animals: notoriously difficult to mitigate. Unsurprisingly, beef production has received negative attention in the press, both for its impact on human health and the environment. At our lighthouse farm at the Lands at Dowth, we partner with Devenish Nutrition and University College Dublin to turn this challenge into a success story: can we design ruminant production systems that contribute positively to human health, to climate mitigation, to biodiversity? Early results from our joint research team encourage us to search for solutions from the soil all the way to society (see side panel: “the science of Lighthouse Farms”).



*Tharic Galuchi and Gary Spence of Devenish Nutrition study multi-species sward at the Lands at Dowth.*

## The Science of Lighthouse Farms

How did we unearth the secrets to success of each of the lighthouse farms? By working with our **local partners**. First, each farm is fully inventorised using our diagnostic farm model called **FarmDesign** (see side panel: “Bringing future farms to life”): we map the crops, assess animal feed and nutrient requirements, energy flows, economics, labour requirements, and the sustainability dimensions of the farm: greenhouse gas emissions, soil carbon balances, nutrient balances and biodiversity.

We team up with local partners to address the unique challenges lighthouse farmers (and those aspiring to adapt) in bilateral programmes, such as **HEARTLAND project** at the Lands of Dowth in Ireland, where five PhDs are jointly supervised by **Devenish Nutrition, University College Dublin** and ourselves. The goal is to develop strategies towards climate-neutral ruminant production systems. This is funded in by an **Industrial Training Network of the European Commission**, in the form of five Early Stage Researchers (PhDs).

Similarly, in **Northern Ethiopia** we partner with local research institutes to develop community-supported management strategies for landscape restoration, in collaboration with **GIZ (the German Development Agency)**.

We are currently in discussion with a range of partners to distil the common ingredients to the successful business models and entrepreneurs of the lighthouse farms. **Stay tuned and join us on our exploration.**

## Common ingredients to success

Together, our eleven lighthouse farms (note that we have left open one vacancy to complete the dozen) show the diversity of solutions that are available, and necessary, for global agriculture to meet the sustainability challenge of the next generation. Do we expect each lighthouse farm to be perfect in all dimensions of sustainability? No: lighthouse farms, too, are continuously evolving and adapting to changing priorities; but each lighthouse farm does radically redefine at least one dimension of sustainability. Do we expect all farmers to relate to every lighthouse example? No we don't, but we have grown our network in such a way that all farmers can find inspiration from at least one of the lighthouse farms.

Yet despite their contrasting approaches, their different scales of operation, the vastly diverse climates they are operating in, all our lighthouse farms also have ingredients in common. It is these common ingredients that we have been studying over the last few years, as they provide the keys for other farmers to design their own future-proof farming systems. So far, we have found **three secrets to the success of all lighthouse farms.**

### 1. Harnessing the power of complexity

All lighthouse farms make use of complexity: they combine multiple varieties and crops (Netherlands, Brazil, Austria), mixed swards (Ireland), or indeed a range of farm enterprises (Latvia, Finland, Spain).

When we visited our colleague Dr Uma on the island of Java, Indonesia, she brought us on a tour of Complex Rice Systems. Here farmers combine paddy rice production with the cultivation of azolla, fish, ducks and border plants. Azolla is an aquatic plant that fixes nitrogen from the air, much like white clover in grassland. The ducks provide pest control, as well as eggs, while the fish recycle nutrients and provide a valuable source of protein and income. Border plants diversify the household

menu and serve as habitats for biodiversity. On their own, each of these components struggles to deliver food in absence of chemical inputs, but put together, they work in synergy and deliver both on a healthy diet and sustainability as human-made ecosystems.

We find the same principles apply in a very different part of the world: the Atlantic rainforest of Brazil. One of the biodiversity hotspots in the world, but less than 20% of its original extent remains today. Here, we find ourselves exploring the successional agroforestry systems of Fazenda da Toca: complex multiyear rotations of vegetables, bushes, citrus trees and woody perennials, that together deliver a variety of food and wood products and, equally important, create corridors between the last remaining patches of virgin rainforest.

But managing complexity does not come easy: if it did, we would have seen a lot more farms reaping its benefits. Complexity comes at a price: it takes labour and it demands a lot of knowledge.

### 2. Combining ecology and technology

To manage the labour requirements, all lighthouse farms combine their human-made ecosystem approach with new technologies. Technology comes in many forms: in some cases it comes in the form of steel; for example the roller-crimper technology used by our arable lighthouse farm in Austria: this one-pass machinery rolls the green manure for direct drilling of the next crop; providing an instant mulch layer that provides nutrients, protects the soil surface and prevents weeds. As we are investigating the merits of an ever-greater diversity of crops, we have joint robotics experts who are designing autonomous machinery to tend to the crops.

But technology can also come in form of management support tools for farmers. In Colombia, our climate-smart lighthouse farm village base their decisions on long-term climatic forecasts made by scientists from the

International Centre for Tropical Agriculture. Similarly, we are building holographic interactive landscapes for our lighthouse community in Northern Ethiopia, to support them in science-based decision making (see side panel “bringing future farms to life”).

In all its manifestations, it is the clever use of technology to unlock and support ecology that allows lighthouse farmers to manage their complex systems.

### 3. Working together to manage the knowledge

The final ingredient to success is that each of our lighthouse farms has found a way for people to work together. It is immensely challenging to reinvent farming systems so that sustainability becomes the engine, rather than constraint, for profitability. If there is one thing that we have learnt, then it is that farmers cannot be expected to make that transformation alone. Our lighthouse farms, however, have shown that a transition *is* within reach if we get people to work together, both within the farm, but also within the wider rural community.

These collaborations come in many forms. Our Latvian dairy/caviar/power-station farm is so complex that the Pilvere family employs a hundred experts, from vets to fish farmers to fulltime technicians in the anaerobic digestion plant, to ensure that they have all the expertise needed. A similar picture appears in a very different setting: at our urban lighthouse farm in Havana, Cuba, where farmer Isis employs a hundred staff, each with their own skill sets, to grow food in the middle of the city.

Closer to the equator, expert knowledge is brought together in many forms that are appropriate to local conditions and traditions: in Brazil, this is in the form of a large organic company Rizoma; in Ethiopia, it comes in the form of local community-supported land management plans, while in Colombia, it is brought together through strong institutional arrangements.



The Global Network of Lighthouse Farms held its inaugural meeting at Wageningen University on 11 December 2019.

### Global classroom and laboratory

This shared learning encouraged us to bring our lighthouse farms together in our Global Network of Lighthouse Farms: our global classroom and laboratory. Together, the lighthouse farms shine their light as inspiring examples of new solutions on the horizon that are available to our farmers and food industry. Together we learn, to inspire not only the next generation of farmers, but also our students who will grow to become the next generation of farmers, policy makers and industry captains, for example at the Regeneration Academy at our lighthouse farm in Spain.

Stay tuned and watch out for our forthcoming column in the Farmer’s Journal to explore each lighthouse farm, and to learn with us as we continue our quest for ingredients to successful entrepreneurship and business models.

Explore the lighthouse farms from the comfort of your home at:

<https://www.lighthousefarmnetwork.com/>

Or follow us on Twitter @FSElighthouse / Instagram FSElighthouse

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