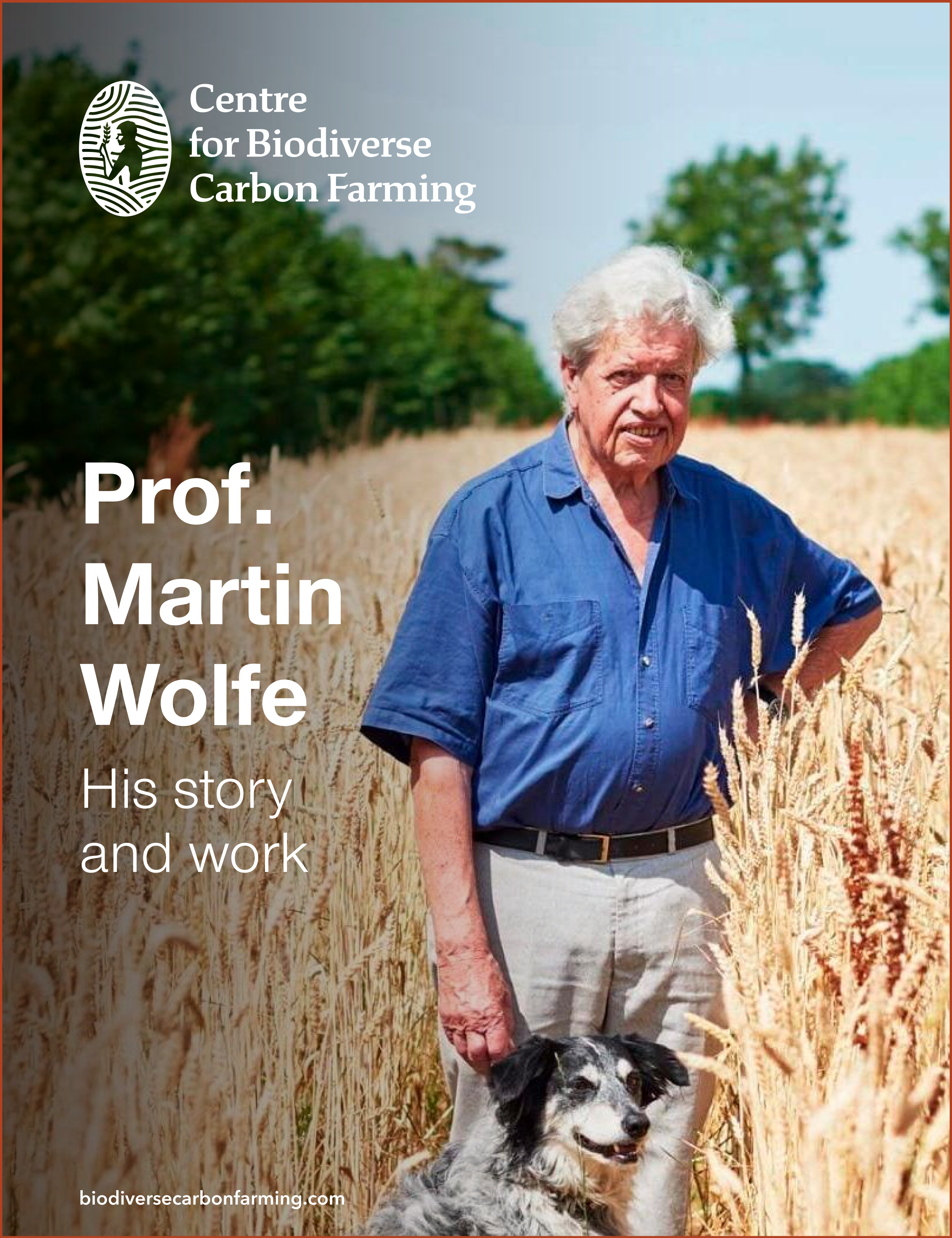
Centre for Biodiverse Carbon Farming



Prof. Martin Wolfe

His story and work

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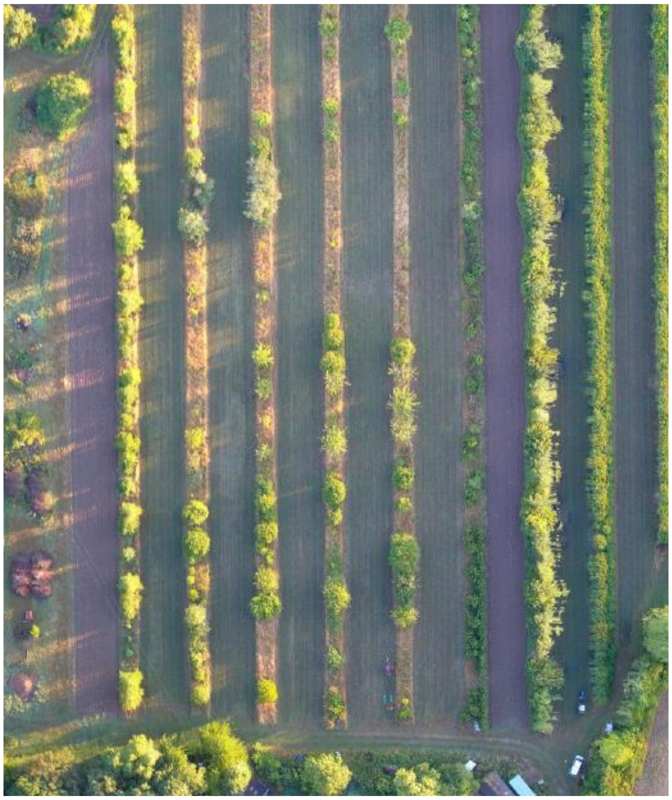

Genetic Diversity as a means of Crop Protection

In the 1970's when Prof. Martin Wolfe was studying wild Barley in Turkey he discovered a unique variety that existed in only one place in the entire world: in the shade of a single rock in one meadow. Barley has sufficient genetic diversity and responsiveness to its environment that this variety had evolved to fit this tiny niche.

Prof. Wolfe was studying the co-evolution of barley with a barley pathogen. His research showed how Barley's relationship with the pathogen that was killing individual plants was responsible for the evolution of Barley as a whole. As Head of Plant Pathology at the Plant Breeding Institute (PBI), Cambridge and afterwards Swiss Federal Institute of Technology (ETH), Zurich, Prof. Wolfe developed cereal crops that mimicked these reflexive relationships as found in nature, first with variety mixtures and later with Composite Cross Populations.

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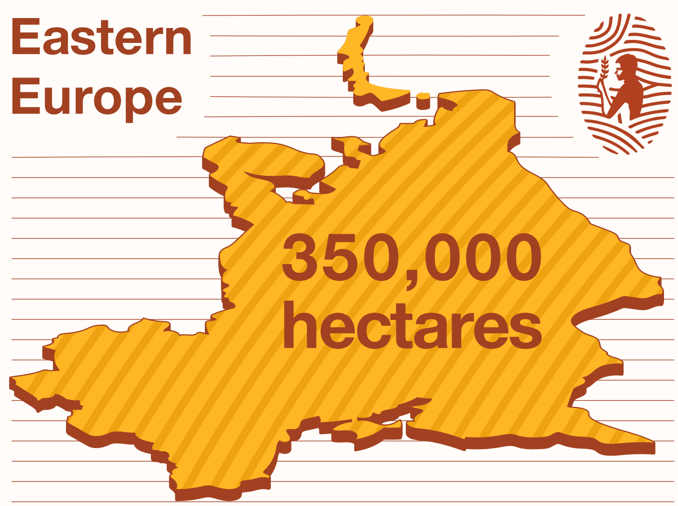
The crops developed by Prof. Wolfe do not require additional human intervention with the application of chemicals or organic crop protection to protect the crops. The genetic diversity within the crop is sufficient to prevent pathogens from creating any threat to yield. These crops became extremely popular in Soviet Eastern Bloc countries that could not afford the products which were being popularised during the Green Revolution.



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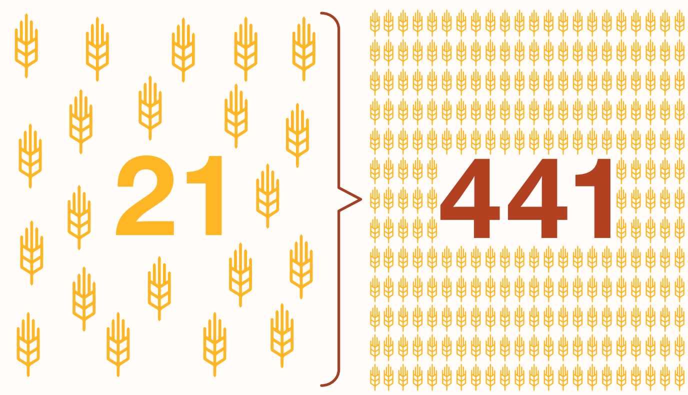
At the end of the 1980's, 350,000 hectares of land were farmed in Eastern Europe using Prof. Wolfe's variety mixture cereals. These crops were also farmed in Pakistan, Bangladesh and elsewhere. At the fall of the Berlin Wall, farms from west of Berlin bought huge swathes of land and converted them to the farming systems they were already using which had arisen from the Green Revolution. The farms using Prof. Wolfe's cereals fell from 350,000 to 20,000 hectares in less than a year.

Every one of these 21 varieties was crossed with every other to create a population with a super-genepool within a single crop.

In the 1990's Prof Wolfe further developed genetically diverse cereal crops to more closely mimic their natural disease resistance and evolution in nature. He crossed 21 varieties of wheat, 10 known for their high quality and 10 known for being high yielding and 1 known for both, Bezostia. Every one of these 21 varieties was crossed with every other to create a super-genepool within a single crop. The crop was then allowed to evolve naturally in the field, with seed being saved after harvest and sowed the following year with no human selection.

In 2018 Prof. Martin Wolfe was given a lifetime achievement award by IFOAM.

This wheat is called YQ, and requires no input crop protection to be used in the farming of the crop. Its genetic diversity makes it extremely resilient to changes in climate and shocks to the growing environment and it evolves to suit the specific environmental conditions on the farm where it is grown. The genetic diversity also contributes positively to the nutrient profile of the crop. It supports the lives of insects, fungi and soil organisms that are often compromised by the application chemical crop protection. These organisms go on to feed larger organisms, mammals and birds and support a web of life beyond the farms where it is grown, as well as feeding human beings.



21 wheat varieties were **crossed** with each other = To obtain **441 different plants**

21 varieties of wheat crossed to **create a super-genepool** then no further human selection

Its genetic diversity makes it extremely resilient to changes in climate and shocks to the growing environment and it evolves to suit the specific environmental conditions on the farm where it is grown.

This wheat is now used by bakers such as E5 Bakehouse and Small Food Bakery who won the BBC Good Food Award in 2018.

In 2018 Prof. Martin Wolfe was given a lifetime achievement award at the IFOAM 1st International Conference on Wheat Landraces in Bologna.

Pioneering Agroforestry

In the 1990's Prof. Wolfe purchased an arable farm in Suffolk, to convert into an agroforestry research site. This site, Wakelyns Agroforesty, became one of two key sites for the Organic Research Centre (ORC) and Prof. Wolfe became the Principle Scientific Advisor to ORC.

Martin developed 4 silvo-arable agroforestry systems.

There he developed 4 silvo-arable agroforestry systems. Each system had a different focus – one for timber, one for fruit, and two with Short Rotation Coppice energy crops. All systems took the formation of alley cropping: a north-south orientation for rows of trees with a croppable area between at a distance calculated to support efficient use of farm machinery.

A **six year rotation** was developed

year **1** cereals	year **2** high nutrient ley	year **3** high nutrient ley
year **4** legume	year **5** high nutrient ley	year **6** high nutrient ley

The high nutrient ley is composed of lucerne, chicory, 2 types of white clover, 2 types of red clover, Birds Foot Trefoil and Black Medic

The high nutrient ley is ideal for use as grazing and pastured poultry were farmed at Wakelyns during the ley period.

Using this ley for pasture can ensure that in such a system there is effectively no fallow period and yet the soil is getting replenished with soil structure, topsoil and nutrient availability increasing over time.

This ley created enough nutrients that no input fertiliser was needed, neither chemical nor organic. Using this ley for pasture can ensure that in such a system there is effectively no fallow period and yet the soil is getting replenished with soil structure, topsoil and nutrient availability increasing over time.

Within these agroforestry systems the Cross Composite Populations mentioned above were included to form the cereal component of the arable rotation. The agroforestry systems Prof. Wolfe developed at Wakleyns require extremely low maintenance. With no application of input fertiliser, nor any input crop protection necessary, soil preparation sowing and harvesting are the main activities during the year.

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The trees serve as a windbreak while mediating temperature extremes and mitigating against both flood and drought. They thus have a positive interaction with the crops and growth of pasture during the ley period. The Short Rotation Coppice energy crops from the Willow and Hazel systems proved to be up to 100% more productive than the same crops in a monoculture. They provided yields of 5tn per hectare per annum oven dried weight. This wood can be gasified with extremely low emissions and used to create electricity and heat which can be used on farm or sold for an additional source of revenue.

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Martin's wife Anne was extremely active in building a vibrant and far-reaching community connected to Wakelyns and brought many other farming and food related enterprises and individuals to work with Wakelyns, making use of the diverse crops and niche's produced by the system.

Wakelyns became a beacon of the success of Agroforestry. The EU Agroforestry program AGFORWARD regularly hosted meetings at Wakelyns, and it was also associated with the European Forestry Initiative's AFINET program. Farmers, academics, bakers, plant breeders and many other interested parties flocked to Wakleyns from around the UK, the EU and around the world to see in person the transformational potential of Agroforestry.

Wakelyns became a beacon of the success of Agroforestry.

Martin passed on the 10.03.2019 and is buried at Wakelyns next to his wife Anne under a tree. Martin considered visiting the system in person to be extremely important, and encouraged people to come and witness the biodiversity of the farm. Wakelyns continues to do this today now that the farm has been taken forward and progressed to the next stage by Prof. Wolfe's sons David and Toby.

Understanding the Protection of Biodiversity

Wheat has more genes than human beings. This means that genetically speaking there is more difference between one wheat plant and another than there is between one human being and another. This genetic diversity is what has enabled the plant to survive and evolve in an environment of pathogens, predators and changing climatic conditions.

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Slight variations in morphology and resistance responses protect individual plants from pathogens and pests. In a field of cereals with high levels of genetic diversity this protects against the proliferation of pathogens that threaten the crop. Individual plants may succumb, but the diversity of their neighbours prevents this from being a wider problem. In actually, the presence of pathogens activates the resistance responses within the plants, ensuring that the genes associated with that resistance will be passed onto the next generation.

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Despite this we have a seed licensing system that actively rallies against genetic diversity.

Within the EU, until recently (Martin and the Organic Research Centre's work and campaigning within the EU has brought some change in this area.), one has not been allowed to licence seed for sale unless it is genetically homogenous. (This is not something that relates solely to GM.) This is one of the reasons why, in fields of cereals, every plant within a crop is near enough genetically identical to every other plant within that crop.

We have a seed licensing system that actively rallies against genetic diversity.

Another factor encouraging this absence of diversity is the drive to standardise the processing of food products. Much farm and processing machinery or processes require uniformity to work most efficiently and farm management becomes more complicated when there are more diverse living things to consider.

This creates a situation where the genetic diversity that has enabled the plant to survive and evolve over time has been removed. Pathogens with much shorter reproductive cycles then have ideal circumstances for their rapid evolution to target the stable and homogenous genetics of a licenced seed, leaving crops extremely vulnerable to epidemic disease. The lack of diversity of other plants and animals within a single field can leave crops vulnerable to predation by insects and molluscs and undermines healthy soil biology, further reducing a crops ability to thrive without support from input crop protection. Planting genetically homogenous seed makes our food system dependent on input pesticides, fungicides, insecticides, herbicides and molluscicides.

The lack of diversity of other plants and animals within a single field leaves crops vulnerable to predation.

Many of these applications do not discriminate well between the organisms that are a threat to the crop and other organisms with a similar biology. Therefore our use of them has dramatic impacts on wild populations of these organisms and the other living things in the food webs of which they are a part.

By farming in polycultures where there are mixtures of diverse tree crops, cereals, shrubs and grasses all integrated into a single system there are further protections provided by biodiversity.

By farming in polycultures where there are mixtures of diverse tree crops, cereals, shrubs and grasses all integrated into a single system there are further protections provided by biodiversity. Birds and predatory insects can provide pest control. Trees can mitigate against temperature extremes and improve water retention and infiltration. Deeper soils and perennial root systems can hold more water. Genetic and species diversity come together to strengthen responses to change in climate and environmental conditions. Diversity provides more opportunity for life to respond when conditions change, which they always do. Ecological functions can then be filled by other living organisms in the system which can enable an ecology to continually adapt. It is more important than ever that we integrate this understanding into our food production.

By mimicking and integrating ourselves with the living systems of this planet, human beings can have a positive impact on biodiversity.

Pioneering scientists and farmers such as Prof. Martin Wolfe are revealing the transformational potential of Biodiverse Farming. By mimicking and integrating ourselves with the living systems of this planet, human beings can have a positive impact on biodiversity and life beyond the human world. Prof. Wolfe was one of these pioneers and his work has enormous potential to enable farmers to increase their profitability, insulate their farms in uncertain times while also improving biodiversity and ecological resilience.