

Regenerative Agriculture

Is this the way forward for Irish Agriculture?

A report for



NUFFIELD IRELAND
Farming Scholarships

by Robbie Byrne

2019 Nuffield Scholar

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Executive Summary

The aim of the research study was to investigate whether Regenerative Agriculture (RA) systems – or Conservation Agriculture (CA) systems or Biological Farming (BF) systems – could assist Irish farmers to farm in a more environmentally friendly way, meet the climate crisis challenges, and be more profitable.

This research study was chosen as it is a subject close to my own heart and farming practices. It is also in recognition of the shifting emphasis and changing direction of the world's agricultural industry (with a specific focus on the Irish agricultural industry), as a result of political, economic, social, and environmental influences.

On initial investigation, trying to distinguish between the three (RA, CA, and BF) systems, it was discovered that there are actually more similarities than differences between them. The importance of soil health is seen as paramount in all three systems.

However, Regenerative Agriculture doesn't just focus on restoring and enhancing resilient systems and relate to the science of managing the soil, landscapes, and communities: It is currently the only farming system that encompasses farmer wellbeing and profitability, thereby including all the components of sustainability. Regenerative Agriculture was the system title chosen for the report to ensure a timely and relevant topic that carries the weight of currently being the most globally recognised sustainable farm system.

Why would a farmer want to change to this farming system?

- Discussions showed that many farmers have a natural interest in farming in a more environmentally sustainable way.
- Other farmers feel that, due to climate change and the European Green Deal (EGD), they will have to reduce nitrogen usage on farms (by 20%) and agri-chemical usage (by 50%) by 2030.
- Consumers are demanding evidence of more environmentally friendly food production practices.

The study demonstrates that:

- Some Irish farmers are successfully employing methods or working systems (whether they are RA, CA, BF, or even perhaps a blend of all these systems).

- Some Irish dairy, beef, and tillage farmers are successfully reducing their total nitrogen usage.
- We have met Irish farmers who have reduced their agri-chemical use in the tillage sector.
- Although there are challenges and obstacles to RA, they're not insurmountable.

Regenerative Agriculture appears to be the way forward to ensure sustainability in Irish Agriculture. In reality, farmers will have very little choice but to engage with it to some extent, and many have recognised this and have started taking steps towards regenerating their soil and farming system. It is an area that is continuously evolving, and more holistic, systems-based research needs to be carried out by all researcher bodies and relevant stakeholders.

Recommendations

- Healthy soils are the basis of all agriculture, and more than a growing medium: they must be protected, replenished, and nourished.
- Buy a spade and go for a pooch.
- Develop a growth mindset.
- Take regular soil and leaf tests for both nutrition and soil biology.
- More Irish-based, and system-wide research must be carried out, including on soil microbes and root mass and the part they play in soil health. Compiling high-quality, meaningful data is the key to building credibility and trust.
- Develop independent systems-based research directly funded and controlled by farmers.
- With the appropriate data, RA practices should be the base to remunerate farmers for the extra carbon sequestered and other public good they provide (similar to the Green Farm Collective in the UK).
- Consider a hybrid system to try and incorporate the best of old and new practices.
- Embrace the potential of plant diversity to improve soil health and realise the benefits of RA for all stakeholders.
- Address the fear of loss of income obstacle, with education and training.

- Incentivise more sustainable RA practices through taxation or through payment for ecosystem services in biodiversity, climate-related action, or water quality improvements. Agribusiness should also reward the added value of RA.
- Minimise the risk of failure by starting RA on small areas on farms.

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Go raibh míle maith agaibh go léir!

Abbreviations

BASE:	Biodiversity, Agriculture, Soils, and Environment
BF:	Biological Farming
CA:	Conservation Agriculture
CAP:	Common Agriculture Policy
CSC:	Contemporary Scholars Conference
CSR:	Corporate Social Responsibility
DAFM:	Department of Agriculture, Food, and Marine
DEFRA:	Department for Environment, Food and Rural Affairs
DLRF:	Dakota Lakes Research Farm
ECAF:	European Conservation Agriculture Federation
EGD:	European Green Deal
EPA:	Environmental Protection Agency
F2F:	Farm to Fork
GFP:	Global Focus Programme
GHG:	Greenhouse gas
GMCC:	Green manure cover crop
IPCC:	Intergovernmental Panel on Climate Change
IPM:	Integrated Pest Management
NGO:	Non-governmental organisations
NOTS:	National Organic Training Skillnet
NPWS:	National Parks and Wildlife Service
NRCS:	National Resource Conversation Service
PGRO:	Processors and Growers Research Organisation
RA:	Regenerative Agriculture

RF: Regenerative Farming
UCD: University College Dublin
USDA: United States Department of Agriculture
VESS: Visual Evaluation of Soil Structure

Objectives

- To clarify the differences and similarities between the various natural farming systems – in other words, Conservation Agriculture (CA), Biological Farming (BF), and Regenerative Agriculture (RA).
- To investigate if these systems could benefit Irish farmers in dealing with future climate, environmental, and production challenges (such as the European Green Deal).
- To research farmers who have been adopting these systems successfully, both here in Ireland and abroad.
- To identify any scientific research that is supporting Regenerative Agriculture practices.

Chapter 1: Personal Introduction

My name is Robbie Byrne. I'm 47 years old, married to Ann Marie and we have four children – James (17), Áine (15), Conor (14), and Harry (12). We live on our family farm in Irishtown, Ardee, Co. Louth. It is a mixed farm of tillage, sheep, beef, and hens. We also have a number of beehives, rare-breed pigs, peacocks, and a wormery on the farm. Loads of diversity there!

I studied agriculture in University College Dublin (UCD) and I completed a Master in Soil and Crop Nutrition degree in 1999, which looked at ways of increasing the nitrogen use efficiency of milling wheat by using plant tissue nutrient analysis.

After working in various roles in agriculture, I set up my own business, Precision Nutrition, in 2007. It focuses on soil and crop nutrition, and biological farming strategies. This was seen as a very niche concept at the time, but it was really the path I wanted to follow.

I'm a member of BASE (Biodiversity, Agriculture, Soils, and Environment) Ireland, which is a part of an international community of farmers, agronomists, and agriculture professionals who are committed to advancing the knowledge and practice of Conservation and Regenerative Agriculture.

Chapter 2: Background to Research Study

Because of my interest in this area, I had spent many years trying to encourage farmers to work in symbiosis with nature. And for a long while, this was considered crazy! But now, due to the climate change crisis and EU legislation, there is a focus on farming sustainably without harming the environment.

EU legislation is currently pushing for 20% reduction in nitrogen and 50% reduction in agri-chemical usage, a big reduction in greenhouse gas (GHG) emissions, and a 25% increase in area under organic farming within Europe, by 2030. This is now encouraging all farmers to look at ways to reach these targets, and Regenerative Agriculture (RA) can help farmers achieve this.

I suppose my interest in this area started with my father. He always had a great interest in nature and how everything inter-connected on the farm – from hedges, to animals, to crops, to birds, to bees, to worms.

When I was a student, Dr. Paddy Barry taught me more in one month of a farm-based work placement than three years of college had managed to do previously. He was the first I ever heard speak about the interaction of one nutrient to another and whether it's a supportive or suppressive interaction.

This sparked an interest and was fuelled years later when I met Neil Fuller (a soil health specialist), who increased my awareness of, and interest in, soil micro-biology and soil health, cover crops, and a large like-minded family through *Acres USA*, an American monthly publication. Through *Acres USA*, I started to learn about all these people who were working using RA methods. I then started to travel to meet them and learn from these soil health advocates.

Also, from employing these concepts on our own farm, I knew that some of them worked, some didn't, but that, overall, RA can help farmers farm more profitably and sustainably.

With my awareness of soil biology, I knew that farmers could benefit themselves, as well as the environment and society at large, by adopting some of these systems. On a simplistic level, I knew that it was possible for farmers to farm with fewer chemical fertilisers and also fewer agri-chemicals and still produce viable, profitable yields. Levels of success can vary from year to year, depending on the weather, whether you own or rent the ground, and also what system you're in (such as dairy versus tillage).

However, in certain years, they may not produce the highest yield achievable. So one of my goals was to pursue a Nuffield Scholarship to research the successful systems on farms across Europe and America and to see what lessons I could learn to help Irish farmers. Crucial to this was finding some focused, practical, peer-reviewed research about these systems.

There is no one silver bullet to solve all the problems that farmers are facing, nor to make any of these nature-friendly farming systems work. As with all businesses, attention to detail and looking after the basics go a long way. You will never beat nature!

My view, along with a lot of the people in the case studies in this Nuffield Project, is that we should be trying to farm more in nature's image (known as *biomimicry*) and as part of our surrounding ecosystem. This is already proving to be of huge benefit to the many farmers who are trying to farm with Integrated Pest Management (IPM) strategies. Louis Bromfield, the author of *Malabar Farm*, was one of the first people who advocated taking the best of the old systems and adding it to the best of the new methodologies and technologies. It's not a matter of simply swapping the new systems for the old systems, but instead combining the best elements of both.

Chapter 3: My Study Tour

My Nuffield journey has taken many turns. I was originally due to start my Nuffield experience in 2019, but due to family circumstances I had to postpone it until 2020. My journey was then cut very short due to Covid-19. We did manage to travel to Tangalooma Beach Resort in Australia to start our Contemporary Scholars Conference (CSC). However, because of Covid-19, we had to return home early. The harsh reality of the pandemic became apparent, and we soon realised that this was going to be a Nuffield experience like no other.

And so it was! I never made it to the rest of our Global Focus Programme (America, Mexico, Peru, France, and Ireland) and everyone returned home due to the lockdown.



Figure 1: The Irish Nuffield Saints and Scholars, Tangalooma Beach, Australia, 2020.

Nuffield has always encouraged us to find ways to overcome obstacles. And the lockdown was a huge obstacle! I was lucky to have already completed some travelling before the lockdown. However, when I was unable to travel to interview people in person, I decided to conduct many of my Nuffield interviews over Zoom. I also participated in lots of online workshops as well as the National Organic Training Skillnet (NOTS) Biofarm Conference. A lot of the speakers involved in this conference spoke on biological farming systems and regenerative agriculture.

My goal was to find people who had real-life experience in Regenerative Agriculture (RA). I looked for people, such as farmers, advisors, and researchers, who would share their challenges and failures, as well as their successes. Many so-called experts don't farm or work as hands-on agronomists. So, I focused on people who are either working on their own farm or advising farmers on RA systems.

In January 2016, I attended the “No-Till on the Plains” Winter Conference in Salina, Kansas. This was a farmer-led conference which ties in with the farmer-owned and farmer-led Dakota Lakes Research Farm (DLRF). At this conference, I met with a lot of farmers, advisors, and researchers all involved in RA.

I was also very fortunate to have travelled to the *Acres USA* Conference in the Winter of 2019, where I met with both Gary Zimmer (author of *The Biological Farmer*) and Gabe Brown (author of *Dirt to Soil*). However, both men are more than authors on the subject of biological agriculture; they are also farmer practitioners. That is what sets these men apart because they practice what they preach. Prior to March 2020, I also got to meet people in the UK such as Mike Harrington, Andy Howard, and Tim Parton.

I was really looking forward to my Nuffield visits and all the further travel that it would entail. My aim is that, when travel is allowed again, I will visit all the people that I have interviewed on Zoom – visit them on their farms and in their businesses. I also plan to visit emerging RA practitioners in the future. It’s all part of an ongoing learning experience that will help me to gain an even deeper understanding of the RA practices that they are employing on their farms. The best research is spending time on farms and seeing these systems in practice.

Chapter 4: What Is Regenerative Agriculture?

“As to methods, there may be a million, then some. But principles are few. The person who grasps the principles can successfully select their own methods.”

Ralph Waldo Emerson

When it comes to sustainable agriculture, there are many methods and principles, which can lead to unnecessary confusion. During the research, it became evident early on that a number of different terms were being used for roughly the same idea. The most common terms encountered were:

- Conservation Agriculture (CA)
- Biological Farming (BF)
- Regenerative Agriculture (RA)

I then asked myself: Which one am I actually studying? Or are they all the same thing, just using different names?

4.1 Conservation Agriculture (CA)

The European Conservation Agriculture Federation (ECAAF) defines Conservation Agriculture (CA) as “a sustainable agricultural production system comprising a set of farming practices adapted to the requirements of crops and local conditions of each region, whose farming and soil management techniques protect the soil from erosion and degradation, improves its quality and biodiversity, contribute to the preservation of natural resources, water and air, whilst optimising yields.”

CA agronomic practices are based on three core principles:

1. Minimum soil disturbance
2. Maintenance of soil covers
3. Cropping system diversity and crop rotations

4.2 Biological Farming (BF)

Biological farmers work with nature, feeding soil life, balancing soil minerals, and tilling soils with a purpose. Biological Farming (BF) improves the environment, reduces erosion,

reduces disease and insect problems, and alters weed pressure, and it accomplishes this by working in harmony with nature.

The phrase “Biological Farming” was coined by Gary Zimmer over 30 years ago in America. Gary is seen as one of the pioneers in BF systems. According to him, BF is a set of common-sense practices that can improve soil health, reduce erosion, improve water quality, reduce disease and insect pressure, alter weed pressure, and produce high-yielding crops. A complete biological farming programme accomplishes this by feeding the soil and managing it for a diverse and dynamic soil microbial community.

“Think of it as a system, not a product,” Gary argues. “And it’s a system that’s practical, sustainable, and profitable.” (Zimmer and Leilani Zimmer-Durand, 2011)

The six principles of BF are:

1. Test and balance your soils and feed the crop a balanced, supplemented diet.
2. Use fertilisers that do the least damage to soil life and plant roots.
3. Apply pesticides and herbicides responsibly while relying on customised management practices to reach maximum genetic potential.
4. Create maximum plant diversity by using green manure crops and tight rotations.
5. Manage the decay of organic materials and the balance of nutrients, air, and water in soil.
6. Feed the soil using carbon from compost, green manures, livestock manures, and crop residues.

Gary’s trademark phrase is that “You must earn the right”. By this he means that if we want to farm and use less chemicals, less soil disturbance, less fertilisers, and so on, we must first learn how to effectively farm with fewer inputs. We need to increase our knowledge on how a more natural, holistic farm works without the need for inputs.

4.3 Regenerative Agriculture (RA)

Robert Rodale was one of the first to use the term “Regenerative Farming” (RF) in the late 1980s. He was the son of J.I. Rodale, who founded the Rodale Institute in America to promote the principles of organic farming. He coined the term “regenerative” to describe a holistic approach to farming that encourages continuous innovation and improvement of environmental, social, and economic measures. RF prioritises soil health while simultaneously encompassing high standards for animal welfare and work fairness. The idea

is to create farm systems that work in harmony with nature to improve quality of life for every creature involved. (Rodale Institute, 2021)

This idea evolved into Regenerative Agriculture (RA). In the preface to Gabe Brown’s book *Dirt to Soil*, Courtney White explains that “Regenerative Agriculture is a biological system for growing food and restoring degraded land. Its goal is to continually advance the health of the soil with practices that promote microbial activity, increase carbon cycling, and improve plant and animal health, nutrition and productivity.” (White, 2018)

Terra Genesis International offers another definition: “Regenerative Agriculture is a system of farming principles and practices that increases biodiversity, enriches soils, improves watersheds, and enhances ecosystem services. It aims to capture carbon in the soil and above-ground biomass (plants), reversing current global trends of atmospheric GHG and climate change. At the same time, it offers increased yields, resilience to climate instability and higher health and vitality for farming and ranching communities.” (Terra Genesis International)

There are six principles to RA:

1. Understand the context of your farm and your mindset.
2. Minimise soil disturbance.
3. Maximise diversity (above and below ground) of both plant and animal species.
4. Keep the ground covered at all times.
5. Maintain a living root in the soil as long as possible throughout the year.
6. Integrate animals – nature does not function without animals.



Figure 2: Six core principles of Regenerative Agriculture.

There is some difference among practitioners about which principles should be included. For instance, some practitioners argue that balancing soil nutrition should be added to the principles of RA, even though it is not listed above.

4.4 Summary

From my understanding, my research, and my travels, the three terms (Conservation Agriculture, Biological Farming, and Regenerative Agriculture) all cover very similar principles. Therefore, heeding the advice of Ralph Waldo Emerson, we can argue that the way forward is to focus on *following the principles*, regardless of what term is used.

Farmers following RA principles may not always get the results that they were expecting, especially in the early years of adoption. However, with trial and error on the farm and better observation, most farmers and advisors whom I spoke with can make their farms more resilient and hopefully reduce some of the input costs. And do not forget that implementing RA systems is good for the climate, environment, and society.

The term that is currently gaining most momentum around the world with farmers, food and beverage agri-businesses, policy makers, and consumers is “Regenerative Agriculture”. This is the reason why Regenerative Agriculture was chosen for this report.

Chapter 5: Drivers of Regenerative Agriculture

Originally, it was the farmers who were interested in farming in harmony with nature who were looking at the Regenerative Agriculture (RA) systems. In other cases, it was people who were in trouble financially and had to look at other methods of farming to make their farms work. For example, they wanted to reduce on-farm expenditure by needing less machinery, lowering fuel bills, and so on. They are looking at these RA systems as a way of reducing input costs, such as agri-chemical and fertiliser costs and machinery prices.

More recently, the interest in RA is mainly being driven by:

- The climate crisis
- International, EU, and national policy
- Consumer demand and corporate social responsibility

5.1 The Climate Crisis

Agriculture is facing many climatic and environmental challenges at the moment – extremes of heat and cold, flooding and drought. Even in a country like Ireland, we are starting to see more incidences of drought occurring. It may only last for 10 days, but it is enough to restrict grass growth, grain fill, or potato fill. It is also predicted that over the next 20 years we will get far more intense rainfall incidences over the Autumn, Winter, and Spring, along with an increase in the number of drought incidents in Summer.

In the 30 years since the Intergovernmental Panel on Climate Change (IPCC) was first established to manage the emerging climate crisis, global greenhouse gas (GHG) emissions have roughly doubled. We have created as much carbon pollution since 1990 than in all human history up to then!

However, the publication in August 2021 of the IPCC's (AR6) report seems to have broken through the public consciousness in a way that its predecessors failed to do. We can now finally see with our own eyes the reality of a rapidly escalating global, climate emergency. Many are now experiencing what psychologists call cognitive consonance on the climate threat. This refers to the real experience of people impacted by or witnessing extreme weather

events. The warning messages from scientists have been amplified, leading to a dramatically heightened state of public arousal and engagement.

Within two days of the AR6 report, the highest temperature ever recorded in Europe occurred in Sicily, which hit 48.8C. All-time temperature records have been broken this Summer all across the world, from places like Estonia, Canada, Western USA, Finland, Turkey, and Russia. For the first time on record, Greenland has experienced rainfall as a result of the temperatures rising above freezing for more than nine hours. It is “unequivocal” that human activity has caused this global warming. (United Nations Intergovernmental Panel on Climate Change (IPCC’s) Sixth Assessment Report)

Climate change is also a key national policy issue here in Ireland. According to Niall Ryan (Department of Agriculture, Food and Marine), the Common Agricultural Policy (CAP) was introduced in the 1960s to ensure that Europe had food security for its members. Every CAP reform since has taken the environment into consideration. However, all the indicators and research on climate change and water quality by the member states (Ireland included) and the non-governmental organisations (NGOs) and so on are showing that the environment is not benefitting from the CAP that is there at present.

Niall explained that the environmental lobby is getting stronger all the time and the EU taxpayer wants to see more being delivered on this front. CAP is one such instrument of European policy that can steer farmers in the direction of higher environmental standards.

Climate change is altering weather patterns, with different areas of the world affected in different ways. This has implications for food production and biodiversity globally, and Ireland is no exception to this.

Projections by Met Éireann suggest that:

- Ireland will see an increase of between 1°C and 1.6°C in mean annual temperatures by mid-century, with the largest increases in the east of the country.
- The number of frost days is projected to decrease by between 50% and 62%.
- The growing season length is projected to increase by 35–40 days by mid-century.
- Rainfall amounts are projected to decrease significantly. Conversely, the frequency of heavy rainfall events is projected to increase by approximately 20%, most notably in Winter. This will lead to extended dry periods in the Summer months.

Research funded by the EPA and Met Éireann (New Climate Projections, 2020) has noted that three high-impact events have occurred since 2000, which is equal to the total number of high-impact events observed in the previous century.

By adapting RA principles, farmers can help mitigate climate change and ensure more sustainable agricultural practices.

5.2 International, EU, and National Policy

5.2.1 International Policy

A number of international policies and agreements are also driving interest in RA.

5.2.1.1 Paris Agreement

The European Union is actively working with other countries and regions to achieve the goals of the Paris Agreement. This is a legally binding international treaty on climate change. It was adopted by 196 Parties at the 21st Conference of the Parties (COP 21) in Paris, on 12 December 2015 and came into force on 4 November 2016.

Its goal is to limit global warming to well below 2 (preferably to 1.5) degrees Celsius, compared to pre-industrial levels.

5.2.1.2 UN Sustainable Goals

The United Nations 2030 agenda includes 17 interlinked Sustainable Development Goals (SDGs) intended to apply universally to all countries. The SDGs are a commitment to eradicate poverty and achieve a sustainable world by 2030 and beyond, with human well-being and a healthy planet at their core. They are a blueprint to achieve a better and more sustainable future for all.

RA can help us to achieve the following SDGs:

- Zero Hunger
- Good Health and Wellbeing
- Clean Water and Sanitation
- Responsible Production and Consumption
- Climate Action
- Life on Land



Figure 3: The 17 UN Sustainable Development Goals.

5.2.2 European Policy

In Europe, a number of policies are also driving RA.

5.2.2.1 The European Green Deal (EGD)

The main policy driver for RA in the EU is the European Green Deal (EGD). Climate action is at its heart. It is an ambitious set of policy initiatives and measures for the next five years and beyond by the European Commission, with the overall goal of making Europe the first climate-neutral bloc in the world by 2050.

Its measures include:

- Cutting GHG emissions
- Reducing fertiliser and agri-chem usage
- Investing in cutting-edge research and innovation
- Preserving Europe's natural environment

The European Green Deal and Its Implications for Ireland

The EGD has two main instruments that impact on Irish and EU agriculture:

- Farm to Fork Strategy
- The EU Biodiversity Strategy

Both of these were launched on the same day, and they indicated that CAP should be linked to these strategies and it should deliver results.



Figure 4: The European Green Deal (EGD) policy areas. (McLoughlin and Deane, 2020)

5.2.2.2 Farm to Fork Strategy

In relation to agriculture, the “Farm to Fork (F2F) Strategy” is at the heart of the Green Deal. It addresses the challenge of sustainable food systems while recognising the inextricable links between healthy people, healthy societies, and a healthy planet.

The Commission’s “Farm to Fork” (F2F) Strategy was formulated to create a more sustainable food policy. It is seen as an opportunity to improve the environment that agriculture depends on. It identifies the need for an accelerated transition to more sustainable food systems, which among other objectives should have a neutral or positive environmental impact, help to mitigate climate change, and adapt to its impacts and reverse the loss of biodiversity. (EPA State of the Environment Report, 2020)

The common agricultural and fisheries policies remain key policy tools, with the Commission proposing that at least 40% of the CAP’s overall budget and at least 30% of the Maritime Fisheries Fund to go towards climate action. This is a clear indication of how seriously the EU is taking the climate crisis.

Significantly, under the strategy, the European Commission will take action on two major fronts. First, a target to reduce nutrient losses by at least 50%, while ensuring no deterioration in soil fertility, will aim to reduce synthetic fertiliser use by at least 20% by 2030. Secondly, targets will be implemented to reduce the overall use of chemical pesticides by 50% by 2030.

The F2F Strategy also includes the following targets to be achieved by 2030:

- Have 25% of EU agricultural land area under organic production
- Reduce the use of antimicrobials in agriculture and aquaculture by 50%

And the question for the farmer is how to use RA to achieve these targets and still deliver yields and profits.

5.2.2.3 EU Soil, Health, and Food Mission

As part of the EU’s Soil, Health, and Food Mission, soil health has been defined as “the continued capacity of soils to provide ecological functions for all forms of life”. In recent times, there has been an increased awareness that the biological communities in soil are an important component of the soils capacity to deliver on these ecological functions.

The EU’s new Soil, Health, and Food Mission aims to “ensure that 75% of soils are healthy by 2030 and are able to provide essential ecosystem services” (Caring for Soil is Caring for Life, 2020), including the provision of food and other biomass, supporting biodiversity, storing and regulating the flow of water, and mitigating the effects of climate change.

One of the core aims of RA is the regeneration and conservation of the soil. Life on earth depends on healthy soils. The soil under our feet is a living ecosystem, home to many fascinating plants and animals, whose invisible interactions ensure our well-being and that of the planet. Soils provide us with nutritious food and other products, as well as with clean water and flourishing habitats for biodiversity. At the same time, soils can help slow the onset of climate change and make us more resilient to extreme climate events such as droughts and floods. “Simply put, healthy living soils keep us, and the world around us, alive.” (Caring for Soil is Caring for Life, 2020)

However, soils are fragile. They can take thousands of years to form but can be destroyed in hours! We need to take care of soils now so they can be safeguarded for future generations as “in the scale of human lifetimes they cannot be considered a renewable resource”. (Weil and Brady, 2017)

Soil degradation is largely driven by how we live and farm. Therefore, it is no surprise that soil condition is at the very heart of the new European Green Deal and the United Nations Sustainable Development Goals.

Niall Ryan argues that soil is seen as the basis of a healthy eco-system: healthy soil, healthy plants, healthy food, and healthy people.

For the past 60 years, soil health has been mostly based on soil chemistry, and to a lesser degree on soil physics. Some soil health pioneers (such as Gary Zimmer and Elaine Ingham) have always put soil *biology* as the main starting point to soil health. They follow a holistic approach, such as Elaine Ingham’s Soil Food Web concept. This approach comes from understanding that all components of soil life are interconnected.



Figure 5: Elaine Ingham’s Soil Food Web.

5.2.3 Irish Policy

In Ireland, a number of policies and bodies are also driving interest in RA.

5.2.3.1 Environmental Protection Agency (EPA)

State of the Environment Report (EPA 2020)

The Environmental Protection Agency (EPA) produces State of the Environment reports every four years. These reports provide timely information and knowledge to the public, policymakers, and key economic sectors in support of action to protect and manage the environment. They also help to drive Irish government policy.

The 2020 report stated that, in 2019, agri-food exports were worth €14.5 billion (Bord Bia, 2020), almost 10% of total exports, and accounted for 173,000 jobs, representing 7.7% of total employment (DAFM, 2019a). These figures demonstrate the importance of the sector to the Irish economy.

The EPA acknowledges that agricultural production is not *solely* associated with the production of food. Farming, when carried out in a manner that is sensitive to the environment, can provide valuable ecosystem services to society, ranging from protecting water from pollution to maintaining nutrient cycles and enhancing biodiversity. These broader ecosystem services need to become an increasingly important part of day-to-day

farming in Ireland, and hopefully farmers will be recognised soon for helping provide these services to society.

Ireland has a reputation for high-quality natural food production, and critical to this reputation is that food produced in Ireland has a low environmental footprint, in conjunction with adherence to strict traceability and animal welfare criteria. However, our clean, green reputation is now at risk as a result of current trends in air pollutant emissions (most importantly ammonia), GHG emissions, water quality, and biodiversity decline.

Of particular concern to the EPA is the use of some pesticides, which are a major contributor to hexachlorobenzene emissions to air in Ireland (EPA, 2020b). Hexachlorobenzene is present as an impurity in or a by-product of some pesticides, such as chlorothalonil. A ban on the use of this pesticide came into effect in May 2020. This has had huge implications for the control of septoria for Irish wheat growers and ramularia for Irish barley growers. This is leading to a search for alternatives, both chemical and cultural. Due to this, Integrated Pest Management (IPM) strategies are now being adopted on more Irish farms to help reduce the threat from both diseases.

As farmers adapt RA practices, they can address many of the EPA concerns while also protecting their livelihoods. As the Food Wise 2025 strategy states, “environmental protection and economic competitiveness are equal and complementary: one will not be achieved at the expense of the other.” Furthermore, “future food production systems must be as focused on managing and sustaining our natural resources as they are on increasing production.”

However, the evidence shows that these two objectives have not been met and, in some areas, that the economic growth of the sector in recent years has occurred at the expense of the environment, as witnessed by the negative trends in water quality, GHG emissions, ammonia emissions, and biodiversity.

5.2.3.2 Biodiversity and Agriculture

Since 1994 it has been compulsory for every EU member state, including Ireland, to have agri-environmental schemes in place in an effort to halt the decline in biodiversity. This is the primary way that farmers are rewarded for farming in an environmentally friendly manner.

There is currently a growing recognition of the importance of biodiversity and “greening” measures in agricultural policy; for example, the contribution of natural capital was included in Food Wise 2025 and Bord Bia’s Origin Green initiative.

Agriculture and other activities are having negative effects on a wide range of habitats and species, such as wetlands, fish, molluscs, terrestrial mammals, and vascular plants. Drainage of land, fertiliser application, clear-felling, under-grazing, and abandonment of land are known pressures that, although local in extent, may influence a much wider area, especially if they affect groundwater supplies or nearby watercourses. Of the 10% of bird species on the Red List, 24% are regarded as “threatened” and 15% are “critically endangered”.

Other studies have indicated a decline of 14% in bee species (National Parks and Wildlife Service (NPWS), 2014). Bumblebees are especially affected, with 7 out of 20 species at risk of extinction. The decline in bees, butterflies, and other insects is stated to be largely the result of monoculture and the drive for ever-increasing levels of productivity, characterised by a loss or neglect of hedgerows, farmland edges, and scrub.

As custodians of our land, farmers are pivotal. When biodiversity is lost on agricultural land, farmers are the first to see the consequences, and when it is restored they are the first to see the benefits. To support the sustainability of both nature and farming, the EU Biodiversity Strategy is aligned with developments in the new CAP and the EU’s Farm to Fork Strategy (EC, 2020b).

5.2.3.3 Water Quality and Agriculture

Water quality and agriculture nutrient pollution (caused by too much nitrogen and phosphorus in our waters) is the key water quality issue impacting on our rivers, lakes, and estuaries.

Research from the EPA is telling us that chemicals and nutrients (such as nitrogen (N) and phosphorus (P)) from our farming activities are making their way back into our water system. The EPA’s most recent report on water quality in Ireland (EPA, 2019b) found that water quality has declined. Two of the main issues driving this deterioration are the excessive levels of nutrients and sediment entering our water courses.

Land management practices, including agriculture, forestry, and peat extraction, all contribute to this problem. In particular, increased agricultural activity in recent years, through increased cattle numbers and fertiliser use, has led to increased nutrient loadings, which in turn impact negatively on water quality.

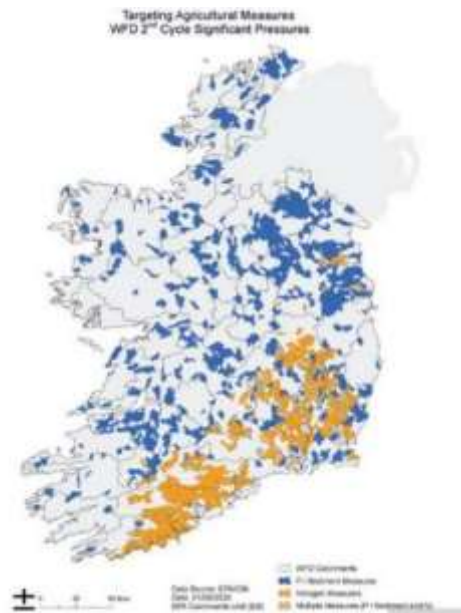


Figure 6: Locations where agricultural measures are needed to target nitrogen (N) and phosphorus (P) losses from farmland. (EPA, 2020)

Jack Nolan, Senior Inspector, Nitrates and Biodiversity Division, DAFM, encourages us to think of nature first. He notes that we shouldn't just talk about water quality, separate to biodiversity, climate, and soil health. We need to talk about nature as a whole, and humans are a large part of this. Jack regularly presents to farmers and other stakeholders and uses the EPA data and results to emphasise the environmental reality on the ground.

5.3 Consumer Demand and Corporate Social Responsibility

A third driver in the interest of Regenerative Agriculture (RA) is consumer demand and the need for corporate social responsibility (CSR).

Consumers are now demanding that food is produced in a “truly” environmentally friendly fashion (and not just in name). Food and beverage manufacturers are starting to tune into the need to reduce their carbon footprint and so pressure is going to start coming on to the suppliers – in this case, the farmers.

In addition, CSR, such as a reduction of emissions on the part of agri-business, has meant that food and beverage manufacturers are looking at the processing, packaging, distribution, and storage aspects of their food chains. In tandem, they are beginning to look at their raw product suppliers (farmers) and trying to identify the carbon and environmental footprint of the food – from farm to fork.

Global potato processor McCain has announced that 100% of its potatoes will be grown using RA practices by 2030. Globally, the Canadian-based firm works with 3,500 farmers, growing 150,000 hectares of potatoes worldwide. The company has said that it sees RA as a way to increase water efficiency, protect against erosion, and capture more carbon.

In the USA, Gabe Brown is currently working with General Mills (global producer of food products) to help guide their farmer suppliers, with the goal of having one million acres under RA practices by 2030.

Consumer demand will always be driven primarily by price, and it remains to be seen whether consumers are willing to pay a premium for low-carbon-footprint foods. As farmers, theory and sentiment tells us “yes”, but practice and experience tell us “no”. So, are the processors, wholesalers, and retailers going to pay farmers more for their cereals, oilseeds, pulses, meat, and milk produce? In reality, probably not.

Sensible policy, which takes into account all stakeholders’ concerns, is needed to support our farmers making the necessary changes towards RA farming practices. RA can help address pressing global issues such as climate change, biodiversity, and water quality, as well as consumer demands for sustainable farming practice and CSR. In addition, these practices can enable farmers to meet their obligations under global, European, and national policies, such as the EU Green Deal, Farm to Fork, the Paris Accord, and the UN Sustainable Development Goals.

However, RA does not have to be a burden for farmers. In fact, it can help them to reduce their input costs while maintaining profitable production levels. In other words, it can be a way forward to more sustainable, efficient, and ultimately profitable farming practices.

Chapter 6: Regenerative Agriculture from Principles to Practice

One of the first things farmers need to do when adopting Regenerative Agriculture (RA) is to open their minds to trying new things. Like any new system, there are bound to be teething problems when applying RA principles. How do farmers minimise their chance of failure and improve their chance of success? If farmers get it wrong, it has a direct financial impact on them.

With the Internet and social media, it is very easy to get lots of information about RA. However, until a farmer starts to trial some of the principles on their own farm in their own geographical area, they won't really get a feeling for how these principles can perform. For example, what works well in America may not work well in Ireland. And what works well in Co. Cork may not work well in Co. Louth. Only trial and error and sharing experiences will provide the answers.

As Jonny Greene, tillage and beef farmer, Co. Kildare, Ireland, states, "Farming is about being in the fields and making decisions on what we see in front of us." He explains that it is important to be able to *understand* "why" you need to do something, and not just be sold the "why". So, although there is a set of principles to follow, within those principles you need to make your own decisions based on your own farm.

Having some knowledge of the system first is essential before trying to implement it. The first thing a farmer should do, before buying any equipment, is adjust their mindset and commit to applying the RA principles. To help with this, farmers can use a "Ten Point Plan" for adopting RA on farms. (These points were developed for tillage farmers, but they could apply to all types of farmers.)

The Ten Point Plan to Adoption of No-Till on Tillage Farms

1. Improve your knowledge about the system, especially weed control.
2. Analyse your soil (aiming at a balanced nutrient and pH status).
3. Avoid soils with bad drainage.
4. Level the soil surface.
5. Eliminate soil compaction.

6. Produce the highest amount of mulch cover possible.
7. Buy a no-till seeding machine.
8. Start on 10% of your farm.
9. Use crop rotations and green manure cover crops (GMCCs).
10. Be prepared to learn constantly and stay up to date with new developments.

When it comes to RA, farmers are currently the experts. When one farmer understands the system, and the ten points above, they can then advise others on how to adopt it. Peer-to-peer farmer “knowledge transfer” plays a significant role in successful uptake of RA.

As Edgar Dale has said, we remember:

- 10% of what we read
- 20% of what we hear
- 30% of what we see
- 50% of what we see and hear
- 70% of what we discuss with others
- 80% of what we personally experience
- 95% of what we teach others

By teaching each other about RA systems, farmers can increase their own expertise.

Chapter 7: USA Case Studies

As part of my research, I interviewed a number of Regenerative Agriculture (RA) practitioners and experts in the USA.

Gabe Brown, Bismarck, North Dakota

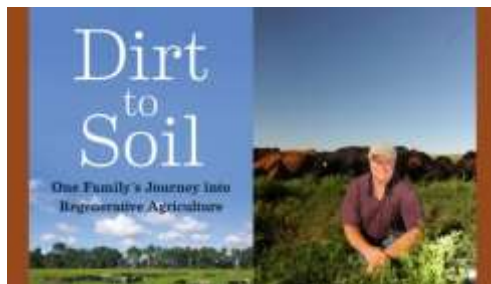


Figure 7: Gabe Brown, author of *Dirt to Soil*.

I was lucky to meet Gabe Brown at the Acres USA Conference in 2019. His name is synonymous with RA in the USA, and indeed around the world. He's a grazing and tillage a farmer, who farms 5,000 acres. He's also the author of the publication *Dirt to Soil*, and was featured in the Netflix film *Kiss the Ground* about soil health and RA.

His mission is to regenerate landscapes for a sustainable future. To achieve this mission, he uses a holistic approach, farming in nature's image (known as *biomimicry*). For Gabe, all life develops from three essential components: soil, water, and sunlight. By focusing on soil health, we can improve both the environment and farm profitability.

Poor returns on the farm started him in RA, and these poor returns forced him to think differently, change his mindset, and seek different advice and ideas. Gradually, since 1993, his farm profitability started to improve when he moved to reducing soil disturbance.

However, the real success came when he introduced cover crops. The cover crops' roots nourish the soil through root exudates. These changes transformed his soil biology and soil health. His farm ecosystem is functioning better and the soils are more biologically active and these factors have reduced overall inputs and costs.

He uses a diverse cropping strategy, including cover and companion crops. By growing a variety of crops, including broad leaves and grasses, he ensures that the soil receives a balanced diet of nutrients.

Gabe believes that adopting RA principles has enabled him to reduce the use of synthetic fertilizers, fungicides, herbicides, and insecticides.

He argues that RA is currently increasing in popularity because it addresses four pressing issues:

1. Low profitability and high input costs
2. Nitrogen, phosphorus, and soil in the water
3. Climate change
4. Human health issues

Gabe calls RA a “win, win” with farmers, processors, government, environment, and consumers all benefiting. He has become a world-renowned advocate for RA, speaking at major conferences and educating farmers on how change their mindsets and put RA principles into action on their farms.

Although RA brings many benefits, it can also lead to some failure and frustration. This is part of the learning process. As Gabe Brown states, “Failure is important, fail at several things a year. Without failure, you do not move forward, and you do not learn. Just make them small failures!” (Brown, 2018)

Ray Archuleta, Seymore, Missouri

Ray Archuleta is a soil scientist with 30 years’ experience working with the Natural Resources Conservation Service (NRCS) as a Soil Conservationist, Water Quality Specialist, and Conservation Agronomist.

As Ralph Aldo Emerson said, “The person who grasps the principles can successfully select their own methods.” Similarly, when working with farmers, Ray emphasises that: “once farmers understand the ‘why’, they will find the way to make the principles work on their farm.”

For Ray, psychology and mindset play a central role in adopting RA. He often says that “we need to go from information knowing to personal knowing.” He means that when farmers learn new principles, they have to apply them on their own farms, building their own personal knowledge.

Another phrase he commonly uses is, “The greatest roadblock in solving a problem is the human mind”, which he attributes to Gabe and Paul Brown. To change farming practices, you first must change farmers’ mindsets.

To encourage farmers to change their mindset, Ray Archuleta set up Understanding Ag with Gabe Brown (above). This company educates farmers in RA principles and practices. They encourage the farmers to mimic nature and its processes as part of understanding what might work best on their farms.

Ray understands the importance of the farmer being out in their own field and trialling the different RA principles on land that is well known to them. This involves, for example, understanding soil type and drainage. This is a common thread running through all the RA pioneers. He gets farmers to look for clues within the natural local heritage and vegetation, to show what would work best from an interconnectedness approach. He quotes the Sioux Indian proverb: “*With all things, in all things, we are related.*”

Ray’s approach is built around three core concepts:

1. Soil is alive.
2. All is one.
3. Mimic nature’s principles (biomimicry).

Dr. Jonathan Lundgren, South Dakota

Dr. Jonathan Lundgren is an ex-USDA scientist, and is an agroecologist, entomologist, farmer, and beekeeper. He is also Director of the Regenerative Agriculture Research Centre and CEO of the Ecdysis Foundation, a research, education, and demonstration farm in South Dakota. Lundgren’s research and education programs focus on assessing the ecological risk of pest management strategies and developing long-term solutions for regenerative food systems.

Lundgren believes that farmers must adopt “profit-driven regenerative practices”. His focus is on insects and biodiversity, and his research has shown that a diverse mix of cover crop plants with different flowering times increases the habitats for predator insect species. He demonstrates how these predators are beneficial in controlling pest insect species and reducing the reliance on chemical pesticides and related costs.

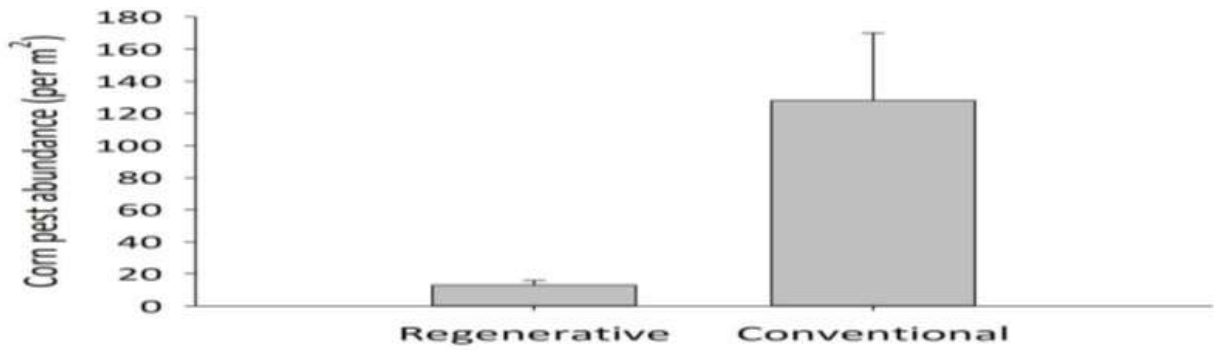


Figure 8: Pest populations in conventional cornfields vs regenerative cornfields.

(La Canne and Lundgren, 2018)

In this study, the overall profitability of conventional and regenerative production systems was evaluated. The RA cornfields implemented three or more practices, such as planting a multi-species cover-crop mix, eliminating pesticide use, abandoning tillage, and integrating livestock. The conventional fields used fewer than two of these practices.

The RA systems had 70% higher profit than the conventional systems. This result was replicated again in his most recently published scientific paper – “Defining And Validating Regenerative Farm Systems Using A Composite Of Ranked Agricultural Practice” (Lundgren, 2021) – where Jonathan’s research demonstrated that the almond farms using the regenerative systems were twice as profitable as their conventional neighbours.

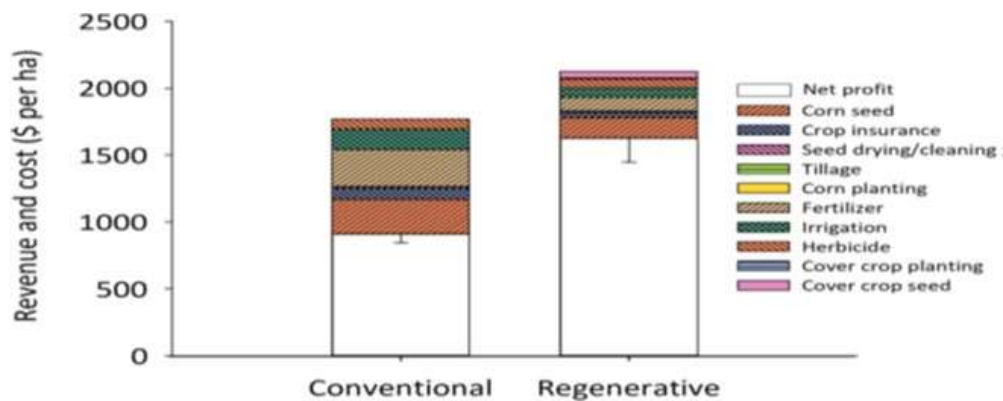


Figure 9: Regenerative corn fields vs conventionally managed corn fields overall profitability.

(La Canne and Lundgren, 2018)

Jonathan’s study focuses on farmers who have been practicing RA systems over a long number of years. Leask (2019), an Australian Nuffield scholar, emphasises that “it takes time, patience, and a lot of trial and error to reach this stage of a ‘mature’ RA farm. A significant number of new skills need to be developed and this all takes time. Farmers need to be able to read their own farm.”

Dr. Dwyane Beck, Dakota Lakes Research Farm (DLRF), Pierre, South Dakota



Figure 10: Dwayne Beck, research director of the DLRF.

I met Dr. Dwyane Beck at the No-Till on the Plains Conference. He is the research director of Dakota Lakes Research Farm (DLRF), a farmer-owned, farmer-led, working research farm. It is one of the most innovative research centres in the world.

Dwyane believes that “conserving soil and water resources should be a primary goal for every producer”. Whereas the producer is often faced with the decision whether to conserve the resource or maximize profit, they must be considered together. During discussion with him, Dwayne argued that what was really lacking in research was long-term, systems-based research that requires a changed mindset to manage ecosystems more efficiently.

The DLRF’s strategy is to use a **holistic approach** to ecosystem management to encourage **transformational change**. As an example of this transformational change, DLRF sets itself 100 Year Visions. One of its transformational goals since 2016, for example, has been to find ways to farm without using any fossil fuel.

“The lightbulb did not result by incrementally making candles better.”

Jay Fuher, USDA Soil Conservation Officer

Dwayne has developed a better understanding of what happens when crops are grown in a manner which places heavy emphasis on developing a healthy, biologically active soil ecology and uses cultural practices (rotation, sanitation, competition, and confusion) as the primary methods of weed disease and pest control.

For Dwayne, weed and pest problems are a symptom of a system that does not contain sufficient diversity. A conventional approach would be to try and control weeds or pests with chemicals or tillage. A **systems approach**, on the other hand, would add a crop to provide the diversity that was lacking. This addresses the cause of the problem, rather than merely treating the symptoms as they appear. He proved this by working with USDA-ARS weed

ecologist Dr. Randy Anderson, showing how weed density decreased over time through using different crop rotations.

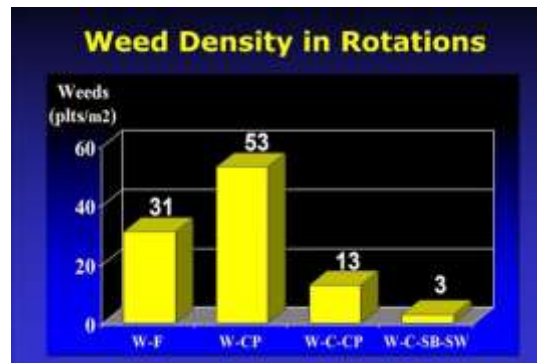


Figure 11: Results from Dr. Randy Anderson Weed Density in Rotations DLRF experiment.

Beck explains that the role of the farmer is to manage ecosystems and also take sunlight, water, and carbon dioxide and make them into products to be sold. Some of the main ecosystem processes that he encourages farmers to educate themselves about are:

- Water cycle
- Energy flow
- Mineral cycle
- Carbon cycle
- Community dynamics

He also encourages farmers to study the native landscape and native ecosystems in their own area. In nature, you won't see bare soil!

Dwayne also adds that if you want to have high levels of microbial-rich healthy soils, you need to provide them with something to eat, and this is living root exudates and crop residues. He considers organic matter as a nutrient, and he encourages farmers to keep working on building soil organic matter levels.

He concludes, "The success at DLRF was not achieved because we set out to improve yields. Rather the goal was to better manage ecosystem processes with local natural systems as the model." Some of the farmers who are partners in DLRF describe applying Dwayne's research strategy as being similar to having a brain transplant!

The RA approach requires farmers to develop new skills and a different attitude. They need to realise that to be sustainable and profitable on a long-term basis, the farming system must

be designed so that natural cycles become an ally rather than an enemy. Inputs such as fertilisers or pesticides then become methods to augment or initiate natural cycles, rather than being tools designed to stop natural processes.

Educating Others: Bud Davis and Rick Bieber

In order to get farmers on board with Regenerative Agriculture (RA), it's important to highlight the benefits of this approach to sustainable farming.

The United States Department of Agriculture (USDA) has developed some simple mobile visuals that can be taken to shows and fairgrounds to show farmers the benefits of RA. Bud Davis, USDA, uses the rainfall simulator to show how cover crops and soil residue can protect soil from erosion and run off from rainfall. It also helps to demonstrate how nutrients are protected in the soil to avoid leaching into water courses.



Figure 12: Rainfall simulator demonstrated by Bud Davis, USDA National Soil Conservation Service.

Visual aids are a useful way to highlight the benefits of RA. This is Rick Bieber's (a no-till farmer from South Dakota) very simple visual of how he tries to stay one step ahead of nature by mixing up his cover crop and cropping sequences. He uses this to educate other farmers about RA benefits.



Figure 13: Rick Bieber's cover crop visual education sheet.

Educating other farmers and sharing knowledge and research are essential in encouraging the adoption of RA. However, different people have different learning styles. Some learn from a book and others learn from a visual presentation or a hands-on demonstration. RA advocates need to accommodate these different learning styles when educating others.

Chapter 8: UK Case Studies

I travelled to the UK in 2020 to meet a number of farmers. I also interviewed them on Zoom.

Neil Fuller, Lincolnshire

Neil is a UK-based soil scientist. He works with farmers and water companies, including Yorkshire Water, to help minimise the risk of nitrogen, phosphorus, agri-chemicals, and soil ending up in rivers. He uses Regenerative Agriculture (RA) principles to help both parties (the farmers and the water companies) achieve their goals.

He says sometimes the biggest challenge is to get farmers to open their minds to use new practices such as planting cover crops, minimising soil disturbance, maximising soil coverage, and so on. To encourage farmers to change their mindsets, Yorkshire Water has introduced an initiative where they pay farmers the cost of cover-crop seeds.

Neil uses the same principles to encourage farmers to lower their carbon footprints for the crops they produce, and also increase carbon sequestration on farm and reduce fossil fuel usage. Farmers are now investigating the trading of some of these carbon credits to bring in an extra source of income.

Neil maintains that without adapting RA principles, a lot of these positives would not have been achieved. He also explained how he has been working with a major UK brewer and maltster, with a view to reducing their carbon footprint of their beer from soil to glass. Neil feels the RA practices benefit everyone involved: farmer, food and drink producer, consumer, government policy makers, and the environment.

Mike Harrington, Oxfordshire

Mike is an agronomist at Edaphos, an independent agronomy firm that provides agronomy services to all types of farms, over an area which covers 9,320 hectares. I visited Mike in Oxfordshire in 2020, and visited some of his clients' farms with him to observe the impact of Mike's advice on the farms. I also visited a Farming and Wildlife Advisory Group (FWAG) farm demonstration in Oxfordshire. Here, we saw a video on the impact of soil ending up in rivers, and how it can be detrimental to spawning fish. This was another example of how a visual aid can help educate farmers about RA.

Mike feels that “the UK has become heavily reliant on chemicals to tackle disease or pest problems. For many growers this has led to poor soil and plant health, below-par rooting systems, less nutrient use, and applying more inputs to depleted soils to find a solution.”

Some of Mike’s clients have reduced chemical inputs by up to 60% and more than halved their nitrogen applications. However, they have also maintained good yields by focusing on soil health, crop rotation, cover crops, and direct drilling.

Mike is leading the drive to help growers achieve sustainable, profitable, reduced-input farming systems. Conventional agronomical advice would be to use chemicals to tackle pest or disease issues in crops. Mike, on the other hand, focuses on building healthy soils and plants that are naturally more resistant to pest and disease attack.

Tim Parton, Staffordshire

Tim Parton, a member of BASE UK, farms 350 hectares of arable and grass land. He is an RA pioneer whose main aim is soil health, and enhancing and harnessing the biology in his cropping system to help his reduce the use of fertilisers and agri-chemicals on his farm. In 2017, he won the *Farmers Weekly (FW)* Award for Soil Farmer of the Year, and in 2020, he won the *FW* Award for Farm Innovator for his pioneering approach with RA.

I met Tim in Spring 2020. He explained that, in his opinion, there is no “Plan-et B”. He has managed to maintain his yields whilst reducing agri-chemical and nitrogen levels overall. Also, by using cover crops and pollinator strips, he increased the number of bird, bat, and insect species on the farm. Tim also introduced wildlife margins to help promote beneficial insects.

This resulted in an increase of these beneficial predators to a level which enabled him to avoid the use of insecticides for the past five years. This shows the importance of supporting our biodiversity through policies at national and international level, as it has a direct effect on the environment and on farm profitability.

He is seeing big improvements in biodiversity on his farm as a result of moving to RA principles. For example, worm numbers have increased and soils are healthier. Soil organic matter has increased by 0.2% per year. Bird counts from a local ringing group show wildlife has returned to the farm in great numbers. New bird species are now being seen, including breeding barn owls and kestrels.

More recently, Tim, with other RA farmers, has set up the innovative Green Farm Collective, an entity that allows companies to invest in a network of British farmers who are creating and managing nature and carbon-enhancing projects on their farms.

Their practices encourage nature, build soil health, increase carbon storage, and protect water courses. The Green Farm Collective provide an opportunity for investors to offset their personal and business environmental footprint with farmers creating and managing nature and carbon-enhancing projects.

Ian Wilkinson, Gloucestershire

I spoke with Ian Wilkinson, Managing Director of Cotswold Seeds, in 2021 over Zoom. Cotswold Seeds, a seed company that specialises in grasses and broadleaf plants, has a reputation for specialising in bespoke seed mixtures which are specifically tailored for the needs of each field. Their aim is to enhance soil fertility while reducing the need for chemical fertiliser, which benefits both animals and the environment.

(Positive animal health results were also found in the UCD Smart Grass Project (2015) in Ireland. Here, it was shown that lambs fed on multi-species swards needed 50% less chemical anthelmintic worm doses, versus lambs on 100% rye grass swards.)

A diverse range of plant species is needed to produce crops that help build soil health and farm resilience. Plant diversity also encourages a wider range of root and microbial diversity in this soil. Plant diversity leads to diversity in root architecture and root depth.

As Ian emphasises, Cotswold Seeds is involved in many research projects with colleges and universities to gather scientific data to support the use of plant diversity in farming. This research has shown that mixtures of legumes and deeper rooting grasses and broadleaves can potentially reduce a lot of the chemical nitrogen needed, especially when compared to monoculture rye grass swards.

Cotswold Seeds is well known for its educational infographics, which help explain the benefits of plant diversity to farmers. For example, the infographic below shows different crops' rooting depths, so that soil structure at different depths can be addressed.

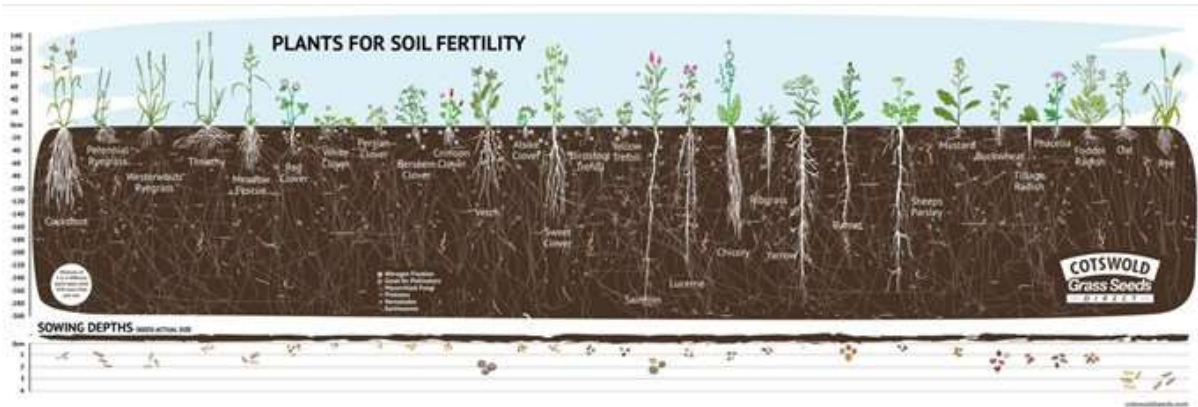


Figure 14: Plant and root diversity above and below ground.

Soil structure can also be improved by the activity of earthworms and other soil biota. Cover crops, minimal / no-till cultivations, and previous crop residues (left in the field) can provide favourable conditions for earthworm numbers.

The Allerton Project in the UK (2015) and the UCD Smart Grass Project (2015) in Ireland also demonstrated that the use of diverse species cover crops helped increase earthworm numbers.

Research has shown that plants exude their own unique blend of sugars, enzymes, and so on, which act as both signals and food for soil microbes. The greater the diversity of plants, the greater the diversity of root exudates, and therefore the greater the diversity of microbes. And, as a result of all this diversity, the ecosystem becomes more robust over time.

Christine Jones, a soil scientist from Australia, has coined the term “liquid carbon pathway”. This explains how when plant root exudates are secreted into the soil, this increases the organic matter of soil. This is another example of how changing your mindset can change how we think about soil health. (Jones, 2021)

Cotswold Seeds are trying to open people’s minds to the benefits of diversity in grazing swards and cover crops in the tillage sector. The shows again the importance of changing mindsets and educating farmers in the drive toward RA. As well as being seed suppliers, Cotswold Seeds is an advocate for farmer education and knowledge sharing.

Steve Townsend, Gloucestershire

I met Steve Townsend in 2020. He is an agronomist and farmer advisor, providing a one-to-one service to farmers. He’s also a member of BASE UK, and is Managing Director of Soil

First Farming. He has been advising farmers for more than 30 years on how to reduce their tillage and increase their use of cover crops to improve soil health.

Steve points out that there are three key areas in soil management: biology, physics, and chemistry. He has placed a special emphasis on increasing soil *biology*, specifically through the use of cover crops and plant diversity, to improve soil fertility, carbon storage, and plant growth. He also emphasises the importance of his farmer clients collaborating with him to learn more about sustainable farming so that they can become experts themselves over time. Rather than simply following his advice, they should delve deeper to understand the rationale behind his advice. Instead of just asking, “What should I do?”, they should ask, “Why should I do it?”

Andy Howard, Kent

Andy is an arable and grass farmer in Kent, UK. He is a 2015 Nuffield scholar, and his report was entitled “The Potential for Companion Cropping and Intercropping on UK Arable Farms”.

I visited Andy on his farm in Autumn 2019. He describes his farming systems as a mix of Conservation Agriculture (CA) and Regenerative Agriculture (RA) principles and practices. Intercropping and companion cropping are the growing of two or more crops in the one field where some or all of them will be taken to harvest. Andy started off by explaining that nature doesn’t do “monoculture”, and 5,000 years ago native Americans were actually intercropping and companion cropping in a system which has become known as “the three sisters”.

On his own farm, Andy mixes varieties of wheat to add diversity to his cereals, which helps him reduce his fungicide inputs. He grows oats with linseed and buckwheat, oats and beans, and wheat and beans, and oilseed rape (OSR) with berseem clover and phacelia. He has recently started growing legume crops, such as chickpeas and lentils, for human consumption. He now supplies an innovative UK food company called Hodmedods.

Andy says that the benefits of intercropping and companion cropping are:

- Less disease pressure
- Less insect or pest pressure
- Less weed pressure
- Improvements in soil health

- Greater soil protection
- Reduction in the need for nitrogen fertiliser

Andy talks about how he feels that he is changing from an input-intensive farming system to a knowledge- and management-intensive system. He says that we should not fear making mistakes as he feels that he learns a great deal from his mistakes and they help him to move forward. To help him separate his companion crops, he did have to build an on-farm separation unit. However, he said that it was a low-cost venture as he recycled lots of on-farm equipment.

He is also involved with many trials on his farm in conjunction with research and education organisations such as PGRO, Diversify project, Agricolology, and Innovative Farmers.

One of the days I visited Andy, Agricolology was hosting a knowledge-sharing day for other farmers on the farm, with Andy sharing his knowledge and experience. He emphasised that the main barrier to uptake of these RA systems is our own imagination.

Chapter 9: Irish Case Studies

For this report, I interviewed a number of Irish farmers, either in person or over Zoom.

Gareth Culligan, Louth

Gareth is a founding member and current chairman of Biology, Agriculture, Soil and Environment (BASE) Ireland, part of an international community of farmers, agronomists, and agriculture professionals who are committed to advancing the knowledge and practice of Regenerative Agriculture (RA). BASE aims to empower members in decision making through the sharing of techniques, on farm learnings, information, and ideas. Members are also encouraged to host farm visits and openly share their experiences. The motto “Farmers Educating Farmers” is core to its strategy, achieved through meetings, foreign trips, seminars, and conferences.

Since 2001, Gareth ceased ploughing and implemented a minimum tillage crop establishment system. In 2008 he went to a direct-drill system. He has based his crop establishment on the key principles of Conservation Agriculture (CA) since then: reduced tillage, cover crops, and rotation. By following these principles, he has been able to reduce the use of fungicides, herbicides, and chemical fertiliser on his farm.

He’s one of the farmers who have been using CA for the longest time in Ireland. By planting more cover crops and companion crops, he has increased the number of natural pest predators on his farm, with the result that he hasn’t used insecticides for the last six years.

In 2018, the farm was visited by Mairead McGuinness MEP and the First Irish Vice-President of the European Parliament with over 30 delegates from the EU’s agricultural committee to view his CA practices. This visit to Gareth’s farm was one of the first signals of political interest in the CA system in Ireland. It highlighted the EU’s awareness of the important link between climate change and current agricultural practice.

Companion cropping is a pivotal part of Gareth’s farming practice. It is defined as the planting of different crops together in proximity for many different reasons. Gareth practices some companion cropping, such as oats with beans or beans with oats; a cash crop and the other being the companion crop. Other companion crops sown include berseem clover, phacelia, and beans with his oil seed rape cash crop. These crops also help to attract bees, hover flies, and other insects into fields.

A UK Nuffield Scholar, Andy Howard's report was based on companion cropping and inter-cropping. Andy has been involved in a lot of research trials with the Processors and Growers Research Organisation (PGRO) on companion cropping in the UK and the results are showing benefits such as the potential to reduce in-field herbicides and insecticides.

Gareth started experimenting with companion cropping after seeing a presentation from Andy Howard. Companion cropping is beneficial in reducing the need for fertilisers and agri-chemicals whilst promoting a friendly habitat for many diverse insects and microbes, and also enhancing soil health.

This is another example of how seemingly unconventional thinking, and mimicking nature, can lead to new farming practices. For example, monoculture cropping does not exist in nature, and Gareth is therefore mimicking nature's approach on his farm.



Figure 15: Gareth Culligan and his son Seán in his summer cover crop, 2019.

Gareth observed, “When you move from conventional ploughing to minimum tillage and then on to no-tillage, good crop establishment can be more difficult to achieve, and this can put pressure on yield potential and profitability. So, good diverse rotations, improving soil health, and maximising cover crops is vital to help give crops as good a start as possible in direct drill situations. Farmer management skills are far more important when working with CA principles.”

Gareth has found that as a starting point to a biological farming or regenerative farming approach, you should do an in-depth soil analysis. This helps to balance soil nutrients, improve nitrogen use efficiency, and phosphorus availability. It also balances calcium/magnesium ratios to help improve soil structure. Gareth follows up regular soil analysis with regular leaf sap tests in the growing crops throughout the season. A weather station on-farm helps guide fertiliser and agri-chemical applications as part of an overall Integrated Pest Management (IPM) strategy.

Gareth aims to balance other nutrients in his soil and in his plants to increase his nitrogen use efficiency. He also does regular sap analysis to monitor his crops' nitrogen requirements and fine-tune his nitrogen applications.

He has adapted three main practices to help him reduce his agri-chemical inputs:

1. Reduction in nitrogen use on crops helps reduce their increased disease susceptibility.
2. Successfully using mixed varieties (particularly on wheat) reduces disease levels in the crop.
3. Using the weather station data allows decisions on the timings of or need for fungicides.

He has moved away from monoculture varieties and uses up to eight wheat varieties, which give different resistances to different diseases and reduce the need for agri-chemicals. He is also hoping, from an epigenetics point of view, that this evolved variety mix suits his farm, his soil, his climate, his microbes, and his area.

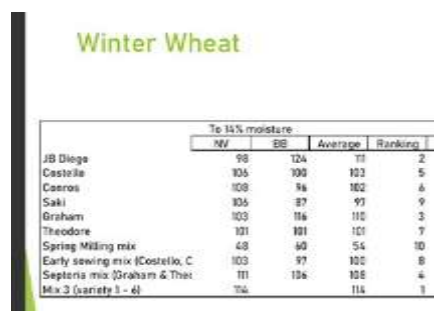


Figure 16: BASE wheat relative yield chart.

These are the benefits Gareth has identified since implementing CA:

- Reduced fossil-fuel requirement
- Reduced dependence on chemical fertilisers and agri-chemicals
- Improved soil health, incorporating the reduction of weeds and disease
- Improved biodiversity by creating a haven for birds, insects, and soil micro-organisms

Gareth is a very innovative and broad-minded farmer – who shares his information freely with regard to his successes and failures.

Jonny Greene, Kildare



Figure 17: Three generations at Jonny Greene's farm.

Jonny Greene is a tillage and beef farmer who has transitioned over the past twenty years from ploughing to minimum tilling to direct drilling. His rotation includes grass, cereals, legumes, and oil seed rape.

Jonny never knows what to call the way he farms, and he feels that it is actually a good thing. He tries to farm without an agronomy rule book. For him, it's not the terms that are important; it's the *actions*. He coaches a youth rugby team, and he uses the example of rugby to describe his farming methodology. Some people know all the rules and terms for playing rugby. However, when playing rugby, what's important is keeping your head up and observing what's actually happening on the rugby field. He calls this heads-up rugby. The same idea applies to his approach to farming.

Jonny describes farming as "being in the field and making decisions based on what we see in front of us". This is a fluid process, depending on what we see in the field at that moment based on seasons, weather patterns, soil type, rotation, cover crops, and so on.

He acknowledges that this means he needs to accept a lot more responsibility for on-farm agronomy decisions. Like the Gary Zimmer motto, Jonny explains that we need to "earn the right" if we want to reduce the use of on farm inputs such as fertilisers, agri-chemicals, and cultivation methods. Of course, he realises that we can't be foolish with our choices as this could affect us financially. Depending on the year and weather patterns, Jonny may or may not see an opportunity to reduce agri-chemical and fertiliser inputs. However, he is always looking for this opportunity.

Strong observational skills and thinking outside-of-the-box skills are needed to open your eyes and minds to how to change your system to reflect nature and develop personal confidence in your decisions and knowledge. Decisions need to be made on very specific

understandings such as soil type. For example, is the soil too wet, too cold, too warm, or too frosty? Learning to be patient is an important skill to develop, and sometimes this is lost in the busyness of life.

Jonny summarises his approach as follows:

- Learn your trade.
- Equip yourself with knowledge.
- Be in your fields very often to be aware.
- Apply common sense.
- Try small changes on small areas first – manage the risk.
- Be a healthy soil manager – avoid compaction on both tillage and grassland.

Jonny looks for simple, yet high-value, cost savings. He tries to use as much organic manures as possible, along with home-saved seed. He also reduces tillage on his farm and introduces cover crops. He always emphasises the need to question why you are doing things and not be swayed by others' advice if it doesn't feel right.

To describe this farmer simply as a no-tiller is not completely correct. Greene uses a systems approach to farming and the entire system leads to his success.

Kenny Roberts, Rathangan, Kildare



Figure 18: Kenny Roberts in his multi-species sward, 2020.

Kenny Roberts is dairy farmer, milking approximately 130 cows. He is also a member of DANÚ, an EIP project that aims to come up with guidelines to help Irish farmers to transition their farms to a more sustainable, biological farming system. DANÚ consists of 12 farmer members, across the beef, dairy, and tillage sectors, making up a mix of organic and conventional farmers. Also, the group has a project lead manager, field technician, and an agronomy advisor.

Kenny's stocking rate is 2.6 livestock units per hectare. He explained that he has reduced his nitrogen requirement and improved cow health and cow fertility by farming a little differently. Before Kenny joined the DANÚ project, he was using 180 units of nitrogen per acre to grow his grass for the year. He has reduced this to 120 units per acre per year, and is still producing the same amount of grass. He has achieved this by applying a variety of methods. For example, he has moved to foliar nitrogen at certain key times in the growing season. He also uses grass measuring and leaf-nutrient SAP analysis to identify and correct nutrient deficiencies and excesses which can induce deficiencies of other nutrients.

These methods help him to fine-tune his overall nitrogen requirements. Kenny notes that although his grass is not as dark green as on neighbouring farms, the volume of grass produced is on a par with his previous higher nitrogen system.

As part of a Teagasc Dairy Discussion Group, Kenny measures his grass growth on a regular basis. Also, following advice from DANÚ, based on early results from the UCD SmartGrass project, he has been incorporating multi-species swards for the last three years. With the increasing pressure to reduce the level of applied nitrogen on farms, there's a need to diversify away from the usual nitrogen-hungry perennial ryegrass and into other areas, such as multi-species swards, including clover not usually used on intensive dairy farms. Initial results are very interesting with a definite reduction in the amount of chemical nitrogen fertiliser needed to grow the same amount of biomass compared to monoculture ryegrass swards.

One other benefit is the ability of the multi-species swards to produce significant yields even during drought periods, especially compared to ryegrass swards. This may become very important if Irish and European temperatures continue to rise over the next two decades as predicted. Kenny believes that there is still much to be learned on the management of multi-species swards, but initial observations indicate that they are proving to be successful.

Another method that Kenny is employing to reduce his nitrogen use is adding microbes to his slurry. He finds that these microbes help aerate and keep the slurry more liquid, saving time and money agitating the slurry. The microbes ensure that the nitrogen in the slurry does not get released as harmful ammonia, a harmful GHG.

Using all these methods, Kenny finds that he is getting a better soil response. This helps him grow more grass and therefore also reduces his need for bought-in chemical fertilisers, especially nitrogen and phosphorus.

Conclusions

Any fool can know. The point is to understand.

Albert Einstein

Understanding the principles of Regenerative Agriculture is essential if we are going to move agriculture towards more sustainable, environmentally friendly practices. Most people are now aware that we can't keep farming the way we were farming over the past 70 years. Things must change! Farmers' mindsets must change! Farming practices must change! And farmers need assistance to make these changes.

It's not just policy and legislative requirements that are driving these changes. Our current farming practices aren't as environmentally friendly as we previously thought. We are on the verge of a biodiversity collapse worldwide and a climate emergency. Soil and water degradation is another major concern at the moment.

Global and EU policy is driving most of this change. However, farmer environmental awareness and consumer demands are also big drivers for a more environmentally friendly systems approach. From my research, Regenerative Agriculture (RA) is a key piece of the jigsaw to finding a solution. Here in Ireland, we can find it difficult to comprehend the true effects our current farming practices are having on our environment. We look out our windows and see lush green fields and bountiful crops. How can we possibly be doing harm when on the outside everything looks so healthy and is in keeping with our "green" image? It is only when we start looking at some of the EPA research findings (2019) that we start to see some of the negative effects that some of our farming actions are having on the environment.

However, we must start a conversation about the financial impact these changes may or may not have on farmers. What incentives are in place to encourage farmers to embrace RA practices? For example, could carbon trading allow farmers to earn money from their surplus carbon sequestration on their farms? This could significantly impact farm profitability.

It is encouraging to see that systems such as Biological Farming, Conservation Agriculture, and Regenerative Agriculture are now being researched better and becoming accepted as ways to protect the environment. As a result, comprehensive research is being funded in both the private and public sectors. However, more is always needed, and it must use a holistic systems approach.

Up to now, RA has been mainly a farmer-led movement. However, the big food processors (such as General Mills, Diageo, McCain Potatoes, and Tesco) are starting to come on board due to demand from environmentally conscious consumers.

RA principles are suitable for all farm sizes and types of farm enterprise. To start off, farmers should always set their goals first. These goals could be, for example, improving soil health, reducing nitrogen, sequestering carbon, or reducing costs.

The principles of RA can work everywhere, but they may need a couple of years to yield results. However, the results we're looking for here in Ireland may be different than other countries. For example, in North Dakota, the main objective is reducing soil erosion. However, that may not be the main objective here in Ireland.

There is enough evidence around the world showing that these methods can do lots of good. In America, if you can conserve moisture, you can grow more than your neighbour. But in a high-yield-potential country like Ireland, if you don't get the aeration in soil to allow for good root establishment and tillering, you may yield less than your neighbour, even if you both get the same rainfall. Therefore, it is the farmer who takes the hit on profit loss, despite all the positives for the environment, such as reduced carbon dioxide emissions, reduced diesel and fossil fuel use, reduction of soil movement, reduction of soil erosion, and so on.

As well as bringing benefits to farmers and their farm profitability, RA brings many benefits to the environment and society at large. Some of these benefits include less contamination of waterways, increased carbon sequestration, and greater biodiversity.

As the transformational researcher Dr. Dwyane Beck says, "Doing the right thing environmentally is almost always the correct economic approach in the long run."

Recommendations

What you hear, you forget;

What you see, you remember;

What you do, you understand.

T. Harv Eker

Based on my research, I recommend the following:

- Open your mind to new ideas and start to think for yourself.
- It all hinges on applying the principles of Regenerative Agriculture (RA). However, try just one of the principles first.
- Maintaining healthy soils is crucial because soil is the factory of agricultural production. It is the common denominator in all farming systems. Therefore, we must protect it, replenish it, and nourish it. For years, soil was looked at as the growing medium, but actually we need to feed the soil and then it, in return, feeds the plants and animals.
- Buy a spade and go for a pooch! Take regular soil tests for both nutrition and soil health parameters. Carry out an on-farm Visual Evaluation of Soil Structure (VESS) study. Follow up with regular crop leaf / sap testing through the growing season. This gives you a baseline of where your starting point is and allows you to monitor change over time. Self-education is an integral part of any RA system.
- The risk on the farm needs to be managed. A common-sense approach to getting started is the best way forward. Start on small acreage and build up over time based on observations and experience from trial and error. Like any change of practice, there is always an increased chance of failure so it's important to try and minimise the risk of failure as much as possible.
- Farmers should invest their own money in some independent research – as they did in the Dakota Lakes Research Centre. This would give them the data to ensure that they have a stronger voice as stakeholders.
- We now know that soil microbes and root mass have a massive part to play in soil health. More research is needed in both of these areas going forward.
- Implement a hybrid system. Take the best from a number of systems (Conservation Agriculture, Biological Farming, and Regenerative Agriculture) and develop the system

that works best on your farm, incorporating the best of the old with the best of the modern.

- Embrace the potential of plant diversity to improve soil health and realise the benefits of RA for all stakeholders.
- Fear of loss of income is a significant obstacle. That's why RA needs a huge amount of education and training, to ensure that farmers don't lose profits at the end of the year. Farmers should look for support – individual farmers, farming groups, consultants, or a combination of these that suits them.
- In addition to CAP payments, policy makers should encourage uptake in more sustainable RA practices if they are proven to provide valuable ecosystem services to society – for example, biodiversity, climate mitigation measures, or improved water quality.
- We need Irish-based research to be done on RA that doesn't just look at one part of the system. A systems approach to research is needed. Compiling high-quality, meaningful data is the key to building credibility and trust.
- If policy or government are not giving extra funds, farmers should consider trying to get an extra financial return from RA practices themselves (for example, being paid through carbon trading or ecosystems services to society, similar to the Green Farm Collective in the UK).
- Farmers should be paid to educate and advise other farmers and policy makers. For example, farmers in England who are taking part in the Sustainable Farming Incentive pilot are being paid to take part in feedback sessions with the Department for Environment, Food and Rural Affairs (DEFRA).
- Farmers should also be rewarded by relevant industries for proactively implementing RA principles. For example, the Yorkshire Water Farmer Payment Initiative pays for the cost of cover-crop seeds and establishment costs to farmers, which in turn helps to reduce the amount of nutrients, agri-chemicals, and soil getting into the water.

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Dr. Jonathan Lundgren

Jack Nolan

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