Improvement & Utilisation of Permanent Pasture to Reduce Cost of Production on UK Sheep Farms

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May 2020

1.0. Abstract

The aim of this project is to identify ways in which UK sheep farm businesses can better utilise permanent pasture in a bid to reduce cost of production. It is thought that utilisation can be improved either through pasture improvement or grazing strategy improvement, or a mix of both. The report looks at the amount of and the use of permanent pasture here in the UK, as well as the important role that is plays, both economically and environmentally.

Information was collected from a range of different sheep farms across New Zealand and a short case study produced from each farm visit. Each farm had drastically different geological characteristics, from being predominantly hill country with vast hectarages of permanent pasture, to more rolling/flat country with the ability to improve pasture with reseeding or over seeding.

By carrying out case studies on a range of different farms in different areas, knowledge was gained on how different methods of improvement and utilisation can be implemented on many different types of UK farms, with different topography, climate, soils, etc. There is no 'standard' answer for the improvement of permanent pasture that will fit all farms, so this project will look at a number of different options, some of which will suit some farm businesses, some of which will not.

2.0. Contents

3.0. Thanks

In May 2019, I was extremely fortunate to be awarded the Samuel Wharry Memorial Award by the National Sheep Association. I would like to start by expressing my gratitude to both the NSA and The Company of the Merchants of The Staple of England for giving me such a fantastic opportunity. In applying for the award, I had to detail where I would like to travel and the topic that I would study, as well as explain how I would then implement and share my learnings.

4.0. Introduction

The uncertain future of the British agricultural industry is something that effects every UK farmer, irrelevant of their farm size or location. At the time, Brexit was a huge concern to many, with the future of many trade deals yet to be decided. A third of UK lamb is exported, with 95% of this being exported to the EU (BMPA, not dated), but the prospect of a 'no-deal' Brexit lead to fears of the market collapsing. Alongside this, there was also a lot of uncertainty surrounding the future of the Basic Payment Scheme. It has now been confirmed that direct payments are being phased out and replaced with a "public money for public goods" scheme. This means that direct payments will be stopped and English farmers will be paid for providing environmental benefits through the new Environmental Land Management (ELM) Scheme. The scheme will include reducing environmental pollution, measuring and reducing climate change and encouraging wildlife. Well managed grassland is now more important than ever; Farms must be looking to survive without relying on direct payments. As farmers, there are many factors that significantly affect our business, some of which we can control, some that we cannot. This concept of a 'Circle of Interest', with the factors we can control on the inside (stock health, soil fertility, grazing management, etc.) and the factors that we cannot control on the outside (politics, weather, trade prices, etc.) should be more widely recognised. As a result, we need to concentrate on and make the best of what we can control to minimise the impact of the factors that we cannot.

With this, I felt (and still feel!) that sheep farmers should be looking to lower their production costs, which in turn will lower risk within the business. Grass, with careful management, has the potential to be the cheapest feed. Despite this, I feel that many sheep farmers (ourselves included) do not utilise grass to its full potential. It is something that has a lot of room for improvement within the sector and would reduce reliance on concentrates. I decided that I wanted to look at the factors influencing the growth and utilisation of permanent pasture, such as soil fertility and grazing systems, specifically where sheep and cattle are cross-grazed. I also expressed my interest in re-seeding and over-seeding routines as a tool in improving permanent pasture quality. To study this, I chose to travel to New Zealand. I was originally worried that this may be seen as too much of a generic answer, but I honestly don't think that grassland management can be seen better elsewhere. Also, with a climate not dissimilar to that of the UK, I felt that a study in New Zealand would be most relevant.

5.0. The Role of Permanent Pasture in the UK

With such an uncertain future facing the UK agricultural industry, we need to be looking at ways to minimise costs of production, and maximising the potential of grassland is a prospective way to do this. Grass is potentially the most important resource in livestock production, yet it is regularly overlooked. Permanent pasture is a centrepiece of UK sheep production and when appropriately managed, can provide the most economic feed throughout the year. However, its performance varies dependant on multiple factors, such as weather patterns and soil health. Grass-fed is seen as more 'natural' in the eye of the consumer, so when choices are made on consumption, livestock reared on grass become more favourable, further highlighting the benefits of grass-fed livestock.

Here in the UK, utilised agricultural area (UAA) stands at around 17.6 million hectares (72% of total UK area). Grassland represents around two thirds of UAA, grouped into temporary, permanent and rough grazing. Permanent grassland is defined as grassland that is over 5 years old and accounts for 40% of UAA, with temporary grass accounting for just 6% and rough grazing at 5% (Figure 1) (Savills, 2019). UK grassland currently supports 3 million head of breeding cattle, plus followers and young stock, and 15 million breeding sheep. The average flock size in the UK is 275 ewes (DEFRA, 2018).

Figure 1. Chart taken from Savills (2019) of Land Use

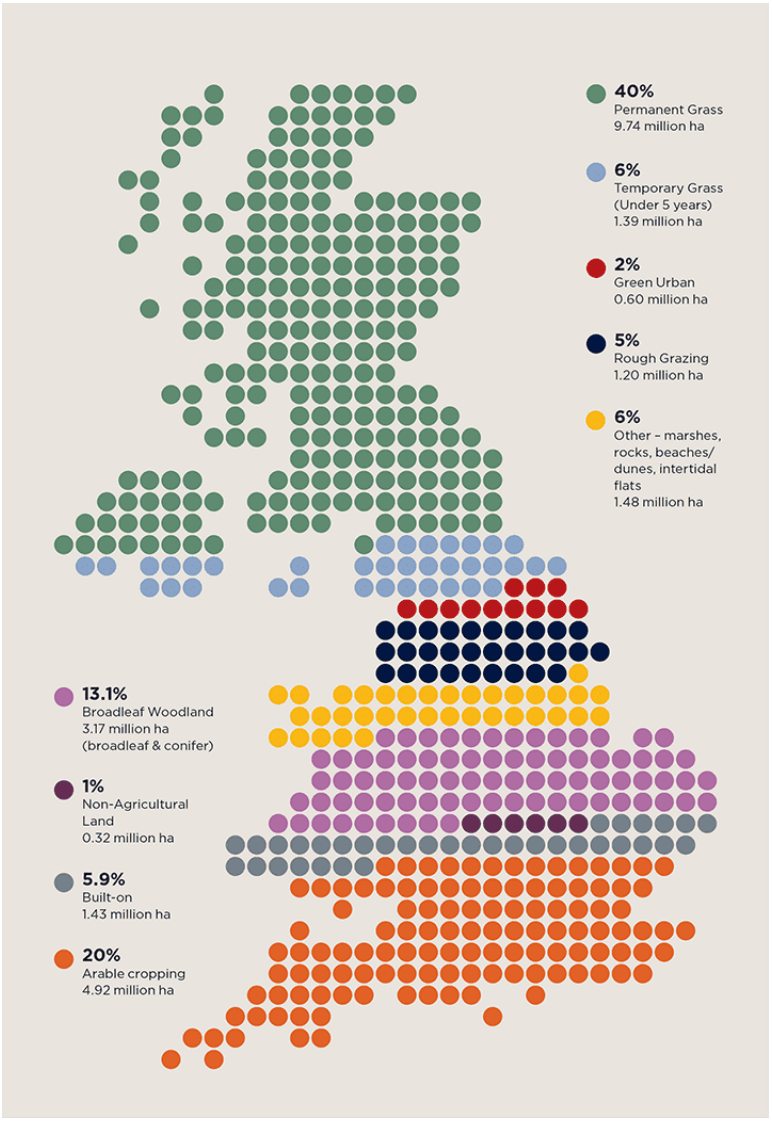


Figure 1. This figure shows proportion of different land uses throughout the UK, as a percentage. It shows that 40% of the UK is permanent grassland, compared to just 6% being temporary grassland.

5.1. Utilisation of Permanent Pasture

Utilisation is a measure of what is eaten compared with what is grown. Therefore, the potential of grassland lies with its utilisation. Utilisation can be maximised by good grazing management, ensuring that it is grazed at the right time, to the right height and with the right amount of stock to ensure limited damage and allowing sufficient recovery periods between re-grazing.
The value of permanent pasture can be significantly underrated. For example, permanent pasture has the potential for 9t Dry Matter (DM) /Ha compared with 12t DM/ha for new leys (Genever, 2018a). However, the cost of production is lower so values can't always be taken at face value. In addition, permanent pasture tends to have a denser sward, which allows it to carry more grazing stock, especially throughout winter months.

Table 1. Average Annual UK grass production:

Lowland	**10-13t DM/ha (Potential is MUCH higher)**
Upland	**4-9 t DM/ha**
Hill	**~2t DM/ha**

Pasture potential primarily depends on soil health and type, sward and grazing management (Genever, 2018a). Soil health is often considered the most important factor in maximising pasture potential, with Soil Organic Carbon (SOC) a top priority. As well as supplying plants with nitrogen, SOC also affects the soils ability to retain moisture (Davies, 2012). Knowing the characteristics of your farms soils is vital to being able to manage them appropriately. Soil type influences drainage, nutrient holding capacity and erosion susceptibility due to different soil structures. Soil improvement has been mentioned in discussions surrounding the new ELM scheme, with it heading towards financial assistance and incentives for protecting and improving soil quality. Introducing diversity to arable rotations in the form of cover crops and diverse leys brings significant benefits. Having a range of different species planted creates a complex and varied root system in the soils. This increases water infiltration and has the potential to reduce or alleviate compaction. In turn, flooding risk is reduced and the water and nutrient holding capacity of soils is increased (AHDB, 2015).

Soil improvement can be assessed using surface assessments to identify sward quality, poaching, weeds and surface capping. This will allow fields to be prioritised based on their requirements in terms of improvement. Research by the Environment Agency has found that since the industrial revolution, there has been a 60% decline in SOC, as well as severe ecosystem and habitat losses. This has come as a result of intensification, to produce more food at a lower cost. Nearly 40% of English and Welsh arable soils are now classed as "degraded" also, whilst less than 7% of grassland and woodland has been given the same status (Noble, 2020). Such declines are in no way sustainable and farms must look at options to improve soil conditions without threatening food production.

Compaction is an increase in soil density and is often a result of increased ground pressure from large machinery or high stocking densities, which with improved management could be avoided. The reduction of pore space in soils reduces the capacity for air and water movement within the soil, increasing runoff and stemming root growth leading to poor fertility and soil health. Over 60% of grassland soils in the England and Wales show signs of compaction (Genever, 2018b).
Compaction significantly restricts the movement of water, air and nutrients through the soil profile. It also restricts the root growth of plants, preventing sufficient uptake of water and nutrients. Fertiliser application to compacted soils is often deemed a waste of time, as utilisation of the fertiliser by the plants will be poor. This leads to an increase in fertiliser runoff and can cause further environmental damage. Waterlogging is often a sign of compaction, as compacted soils will not allow water to drain away, therefore this could be included in surface assessments when prioritising fields for improvement. If the soils cannot drain, they stay colder for longer than well drained soils, which reduces the growing period, impacting on grazing and subsequent grass management. A mentioned above, compaction can be caused by livestock poaching. Generally, this is observed more often with cattle than sheep, however it does occur. Gateway areas and areas where livestock gather frequently such as around water troughs and feeders are the areas most at risk from livestock poaching. This can be reduced by management strategies such as regularly moving feeders and troughs, as well as having multiple entry points to fields where possible. Placing feeders and troughs on concrete pads will also limit

poaching damage. Another method for reducing compaction through livestock is through careful management of stocking densities and using grazing strategies such as rotational grazing, which reduces livestock compaction as the animals are in one area for for a shorter period of time with a longer 'rest' period for the land, before animals are returned to re-graze.

Implementing soil testing policies will allow a detailed picture to be given of each field, meaning that fertiliser application can be tailored to optimise returns. Soil nutrient shortfalls are very common in permanent pasture. Addressing deficits is vital for improving production and increasing feed value. Grasses lignify and go to seed much faster if soil nutrition is inadequate reducing feed value for livestock. Pastures cropped for silage or hay do not get nutrients replaced in the form of stock manure so need applications to balance offtakes. Application of lime to maintain correct soil pH improves grass response to nutrient application, soil structure, optimises trace nutrient availability and reduces nutrient loss. Weed burdens often suggest that there are other underlying issues relating to soil fertility.

Table 2. Common UK Grassland Weeds and Potential Causes

Weed	**Cause**
Thistles	Often indicate low calcium and pH, high potassium and Sulphur
Docks	Prone to Soils with high potassium: phosphorous ratio and low calcium
Buttercups	Thrive in compacted soils
Daisies	Thrive in soils with low pH
Nettles	Thrive in wet soils and like high N levels (often seen in poached areas, where feeders may have been)

Weed burdens often suggest that there are other underlying issues relating to soil fertility (See Table 1). Weed grasses tend to become an issue in leys when soil fertility is lowland the growth potential of the selected species is prohibited. This is especially seen in soils low in phosphorous. Common weeds include thistles, docks, buttercups, daisies and nettles, but brown Top tends to be the most common weed grass found (Moot, 2017). Understanding these allows for better control, rather than just repeatedly spraying to eradicate. Weed burdens can also have direct effects on livestock. For example, Orf is commonly known as 'thistle disease'. This is because lambs grazing areas with a high density of thistles are prone to facial cuts caused by the thistles, which allows the virus to enter (Lewis, 1996).

5.1.1. Sward Species

Permanent pasture swards tend to be made up of a diverse mix of indigenous species, that are dense and vigorous. Varieties with a range of heading dates allow for maximum utilisation and minimal wastage. Knowing and identifying the species within a sward will allow for the stocking rate to be matched to the grass availability, reducing wastage during periods of peak growth.

Similar to the UK, the most commonly grown pasture species in New Zealand are ryegrass and white clover. They're grown complimentarily alongside each other. Ryegrass grows early in the spring, with white clover kicking in later on. The clover also fixes nitrogen, which becomes available to the ryegrass. Both species require high fertility soils, predominantly high phosphorous levels (Moot, 2017).

5.1.2. Environmental Benefit of Permanent Pastures

In the UK, nearly a third of SOC is found in the uplands, where there are high levels of permanent pasture. 70% of the land grazed by sheep is land that is unsuitable for growing crops on (AHDB, 2020). Soils are the largest sink of atmospheric carbon, with almost half of these soils under grassland. Conversion of arable to grassland can increase SOC by up to 19% (Conant *et al.,* 2001), whereas study by Forster *et al.* in 2018 found that the management of upland grassland (grazing and/or cutting) showed little difference in SOC levels.

To combat climate change and work our way towards a goal of Net Zero, we must find a way to balance the carbon emitted with the carbon sequestered. One of the most efficient ways to sequester carbon, is for growing plants absorb carbon from the atmosphere via photosynthesis, storing it in the soil as live or dead plant material. Uplands and peat soils are the largest store of SOC here in the UK. They account for 42% of total SOC stores (NSA, 2016).

5.1.3. Grazing Management

Grazing management was repeatedly stated as being the most important factor for utilisation of grassland, throughout my trip. There is a fine line between over-grazing and under-grazing, and both have the potential to be extremely detrimental to the pasture long-term. Headage payments, which were introduced here in the UK in the 1970s, led to significant over-grazing (Gaskell, 2010). But under-grazing can also be detrimental, with grasses quickly lignifying and losing their nutritional value. To be able to graze pasture effectively, it is important to identify different types of pasture and understand how their root systems work (Beef & Lamb NZ, 2020).

Both when visiting farms in New Zealand and talking to farmers here in the UK, grazing management was named as one of the most important factors to consider. Many said that keeping a close eye on pasture cover and moving set livestock groups dependant on the cover was key. The majority of farms that I visited in New Zealand were all grazing lambs, followed by light ewes, main mob ewes and then cattle. This allowed the lambs to take the first pick, with any lighter ewes getting second picking. This allowed a grazing form of feed allocation for those groups that needed it most. Cattle are much less selective grazers (Mosavat and Chamani, 2013) and so were used by most farmers as 'toppers' to keep grazing fresh. They reduce the need for topping, which reduces diesel costs and produce a calf as a bonus source of income – win win!

5.1.4. Re-seeding/Over-seeding

Reseeding offers plenty of benefits, such as improved yields and pasture quality, but it comes at a large cost. Therefore, it is often more popular to renew existing swards by over-seeding, which comes at a much lower cost. Conventional re-seed cost roughly £120 per acre, whereas over-seeding can be less than half, at £30 per acre (Cotswold Seeds, 2017).

Here in the UK, it is common for farms to be aiming to reseed 10% grassland/year. This needs to be driven by DM production though, rather than just done as a matter of course. Understanding factors limiting performance is vital, prior to reseeding. Consider reseeding when the levels of desired species fall below 50% (Genever, 2018a).

5.2. The Regenerative Route

Regenerative Agriculture is a bit of a hot topic at the moment, and interesting it tends to have farmers divided down the middle either in favour or against, with little sitting on the fence. Regenerative Agriculture is a system of farming principles that increases biodiversity, enriches soils and enhances ecosystems. It aims to capture carbon in the soil and surface biomass and to reduce the current trend of atmospheric accumulation (Terra Genesis International, 2020). Those following the regenerative farming route also claim that it offers increased resilience against climate instability.

Figures show that fertile topsoil levels are depleting, so improved farming practices are vital to help rebuild the soil's carbon stores to prevent further losses of greenhouse gases from our soils. Improved practices include careful management of grazing to reduce soil compaction and improve soil structure. Holistic grazing practices have shown that focusing on the amount of time an area is grazed is key, rather than simply on the stocking density of the area. Holistic grazing mimics the natural movement and grazing behaviours of herbivores, where the animals graze in dense groups, moving regularly (Perry, 2016). Grazing livestock in this way reduces the selective grazing habits seen in set stocking setups and gives grassland longer to recover before being grazed again.

6.0. New Zealand Case Studies

On January the 2nd of this year, I flew out to New Zealand for a 6-week study tour. I visited 10 different farms across the country and whilst a lot of practices where fairly standard, each farm offered a different view towards different areas of my project.

6.1. Ian & Shelley Dew-Hopkins – Rangiwahia, North Island

Ian and Shelley farm 560 hectares in the central North Island. There is a mix of steep hill country, rolling hills and flat land. There is 125 hectares of croppable land, which is put into forage crops to finish both lambs and cattle. There are 3,350 ewes wintered (including replacement hoggets) alongside 140 suckler cows. Unlike the majority of properties I visited, Ian & Shelley are finishing all lambs and cattle on the forage crops on the croppable land. The permanent pasture found on the steep hill country is rotationally grazed by lambs, ewes and cattle. The ewes only ever graze this ground, whilst the lambs and cattle are moved onto the better pasture and forage crops either to be finished for slaughter or to maintain condition.

Figure 2. Flat, croppable land, surrounded by permanent pasture on rolling hills.

Figure 3. Steep Hill Country.

Figure 3. Unimproved permanent pasture that is rotationally grazed. Gorse is chemically controlled on the hills.

6.2. Orari Gorge Station – Geraldine, South Island

Orari Gorge Station was first settled along with Mount Peel Station in 1856 by Charles Tripp and J.B. Acland. In 1859 Tripp and Acland divided the properties with Tripp taking Orari Gorge and Acland Mt. Peel. Orari Gorge included the Four Peaks and Blue Mountain but the Four Peaks and the Tripp Settlement flats were sold off in 1910. The Blue Mountain (35,000 acres) had to be sold in 1947 to pay for the death duties incurred by David and Mowbray Tripp who were killed in action.

Major changes occurred in the early 1980's with a switch away from extensive grazing to more intensive grazing and much more stock finished on the farm. This was achieved by greater subdivision and fertiliser use.

- In 1979 there were 13 hill blocks and 40 paddocks.
- In 1987 there were 40 hill blocks and 120 paddocks.
- "Kennleworth" repurchased in 1984, 94ha of flat (14 paddocks) and 575ha of hill (14 blocks).
- In 1983 the new 10 stand woolshed and covered yards were completed.
- Water scheme (gravity fed) installed in 1989 with troughs in most paddocks.

- The South Canterbury Romney Group Breeding Scheme was set up in 1982 and easy care Romneys were introduced from the North Island.
- Red deer were introduced in 1989 with 250 ha of flats and downs deer fenced. In 1999 and 2000, 1000ha of the hill were deer fenced involving 42km of fencing and a 4km lane.
- The Nithdale Hereford stud moved up to Orari Gorge from Southland in 1992, renamed Orari Gorge Herefords in 2010.
- New cattle yards built in 2005.
- Second piped water scheme installed in 2008 to replace open water race on the flats.

Orari Gorge Station is now 4,350ha consisting of approximately 3,000ha of hill country (Kaikoura/Hurunui soils), 700ha of downs (Kakahu soils) and 500ha of flats (Hororata/Waimakariri soils).

Figure 4. Shepherd and his dogs in the Rolling Hill country of Orari Gorge Station.

Figure 4. Mustering the hill country of Orari Gorge

Figure 5. The Hill country of Orari Gorge Station.

- The woolshed is 750 feet above sea level and the highest point on the property is 3,500 feet (1,048m)
- Average rainfall is 1200mm reasonably evenly distributed but slightly less in the winter
- Most rain comes with the south west wind, the north west wind is warm and dry
- A few light falls of snow are expected on the flat most years. More regular and deeper snow on the hill and a bigger snow of 2 or 3 feet is expected about every 10 years or so.
- There are seven full time staff on the farm plus a full time gardener who also looks after trees, shelter belts and the historic buildings.
- Fertiliser applied to the downs, lower hill and flats each autumn.
- Lime applied regularly to flats and downs. 1,000 ton of lime flown onto the hill in 2018 to improve production.
- Strategic use of nitrogen and short rotation grasses for extra spring feed.
- A big push to increase legumes including pure swards of red and white clover started in 2018.
- Subdivision and installation of extra water troughs continues each year to improve pasture utilisation.

Charlie Tripp started the Nithdale Hereford stud in 1948 and started performance recording the cows and progeny about 10 years later. The stud was moved up to Orari Gorge in 1992 and they currently sell about 30 rising 2-year-old bulls at the annual on farm sale each June. The cows are wintered on the hill country with the commercial cows, from weaning to calving. They are then calved in September on the flats as each calf is tagged and weighed at birth. The calves spend their first winter (as rising 1 year olds) on forage crop but otherwise are on grass. All heifers have to calve as 2 year olds and have to get in calf every year. Animals are culled on performance, EBVs and structure.

Although the South Canterbury Romney Group breeding Scheme has been disbanded, the Orari Gorge Romney stud is still going. All ewes are single sire mated and all lambs are tagged at birth. Ewes are selected for performance (actual lamb production), breeding values, structure and type. Ewes are never drenched with anthelmintics. The ewes are fed on grass alone all year round, often on the hill and they have to get in lamb in the 1st cycle. After weaning the ram hoggets are run in one mob right through to sale time. They are tested for resistance and resilience to worms, eye muscle scanned, individually fleece weighed and regularly weighed to establish growth rates. They are also individually inspected for

conformation three times before they are offered for sale. The RomTex (maternal) stud was started in 2008 and the Terminal stud in 2018.

The commercial cows (Herefords) are wintered on the high country (up to 3,500 feet) with the stud cows, and then calve on the lower hill country in September. Heifers calve as 2 year olds and have to get in calf every year (2 cycles with the bull). The first calvers are also performance recorded with all calves tagged at birth. Mothers of the smaller calves or any dry cows are culled at weaning. All male calves are kept entire and sold to dairy farmers for breeding at 13 months old when over 400kg.

To try and match feed supply vs demand, ewes are mated at specific times of the year depending on where they are grazing / lambing. For example, the ewes lambing on the lowest country go to the terminal sire at the beginning of April. The ewes to lamb on the flats go to the ram on the 12th April. Those on the downs on the 19thof April. The lower hill on the 27th April and finally the higher hill ewes on the 5th May. The aim is to wean 140% over the whole property, mostly unshepherded, with all lambs finished.

The hinds are on the hill all year round. 30% of hinds go to Wapiti/Elk stags, the rest go to English. A move from weaning post roar to pre roar in 2018/19 allowed improvement to conception rates. They aim to finish yearlings from October at 60kg with most killed before Christmas. Yearling hinds are mated on the downs and then fawn as 2 year olds on the hill. In 2015 and 2019, this farm won the Silver Fern Farms Venison supplier of the year.

There is approximately 700ha of native bush of which over 500ha is fenced off and protected (not commercially grazed).

6.3. Scott & Kjersti Walker – Tapanui, South Island

Scott and Kjersti Walker manage 500 hectares of organic farmland, running a mixture of breeding ewes, replacements and suckler cattle on a mix of rolling country and steep hills. Having a fairly limited knowledge surrounding organic farming, this was probably the most eye-opening visit for me. Like everywhere else I visited, the stock are rotationally grazed all year round, with the exception of set-stocking the ewes during lambing. There is a strict grazing strategy which aims to maintain grass quality, reduce residual grazing and help with parasite challenges. The single biggest challenge is rainfall, with it often being unreliable. As a result, the number of lambs finished on-farm varies significantly year-to-year. In a good year, 80% of lambs will be finished. All lambs are off-farm by the end of April, to relieve winter grazing pressure. To try and reduce the farms dependability on rainfall, Scott is continually building soil carbon levels to increase the soil's ability to retain moisture. This is predominantly done through rotational grazing, which allows vegetation to recover before being grazed again. By allowing this recovery time, the plants build up a larger and strong root system, in turn increasing the levels SOC.

Figure 6. Handling Pens

Figure 6. Breeding ewe MOT, prior to tupping

Each year around 5% of the grazing is reseeded, providing conditions permit. Rather than putting in a ryegrass/clover mixture, a much more diverse sward is established. This increases the durability and longevity of the pasture, improves feed quality and enhances the use of water and nutrients, the latter of which increases the farms tolerance to drought. Growing a diverse mix of species has the potential to increase overall forage yield, due to the 'overyielding effect'. This is where different species, with different growing habits, grow in different spaces and thrive at different points throughout the growing system of the ley (Cotswold Seeds, 2018).

Figure 7. Diverse forage crop

Figure 7. The reseeds are extremely diverse, containing a mixture of grasses, clovers, legumes and root crops.

Unlike conventional farming systems that assign specific paddocks to finishing lambs each year, the Walkers are unable to do this due to the parasite implications that come with grazing the same stock class on the same ground yearly, so must ensure that paddocks carry sufficient cover to meet grazing requirements. Hence why they have opted for a combination of use of diverse leys, reseeding and rotational grazing.

Figure 8. Mixed Grazing of Cattle and Sheep

Figure 8. Lambs and cattle are grazed alongside each other to reduce parasite burdens (January 2020)

6.4. Ben & Sarah Dooley – Wyndham, South Island

Ben and Sarah Dooley farm 262 hectares (250 effective) in Southland, on the South Island of New Zealand. The country can be described as "*predominantly rolling hills with some flat areas and some steep areas".* The area is "*summer safe*", usually receiving plenty of rainfall year-round, so summer droughts are rare. They run 2400 Romney ewes, keeping around 600 replacements each year, which they put to the ram as 2-tooth ewes. Their average lambing percentage is 143% and they aim to finish lambs with a 20kg carcase.

Figure 9. The Rolling Hill Country of Sunnyside Farm.

Figure 9. It's steeper than it looks! January 2020

For the majority of the year, the farm is rotationally grazed, apart from around 6 weeks from the end of May, when the stock is moved onto forage swedes. This allows for the grassland to be rested prior to lambing, when they will be set stocked until the ewes and lambs are gathered for tailing. From then, the rotation begins again, through until the following May.

As well as the sheep, the Dooley's also buy in around 50 dairy beef calves each year, which they finish at 18-20 months. The cattle are grazed alongside certain mobs of sheep as part of the rotation. The cattle are effectively used as 'toppers' on the grassland, happily grazing down longer grassland that may have flurish ahead of the rotation. They are only put onto paddocks designated for lamb fattening to finish.

Each year, around 8% of the grassland is reseeded, following a crop of forage swedes. These paddocks are used to finish lambs on, with lambs usually stocked at a rate of 60 per hectare. Although this can vary quite dramatically dependant on the year. Species selection is considered vital when establishing the new leys. The Dooley's use a grass and clover mixture that has a single grass variety, allowing for simple grazing management throughout the season. However, the single variety of grass does differs between paddocks. This allows forvariation between paddocks such as maturing dates of plant species and prevents late maturing varieties being annihilated whilst the early maturing varieties thrive, and visa versa.

Ben and Sarah closely monitor the health and fertility of their soil, with Ben pinning soil fertility as the main factor effecting the performance of their grassland. Sarah, meanwhile, attributes the high performance of their grassland to the careful grazing management – "*you've gotta know what stock will eat what and when!".*

6.5. Dasher Station – Oamaru, South Island

Grant and Charlotte McNaughton farm 6300 hectares near Oamaru, in the South Island. Of the 6300 hectares, 570 hectares are 'croppable' – the rest is steep hill country. They run 7000 breeding ewes alongside 400 suckler cattle, with the cattle seen as a way to top longer paddocks, with the bonus of a calf to sell. Grant and Charlotte purchased Dasher Station 7 years ago, and feel that having the mortgage and debt really pushes them towards improvements at minimal cost. Grant introduced me to the 'Circle of Influence' idea, where you have to focus on what you can control (these are the factors inside the circle) such as animal health, stocking densities and marketing, to minimise the impact of the things you cannot control (the factors outside the circle), such as the weather, politics and lamb prices.

Figure 10. Steep Hill Country of Dasher Station

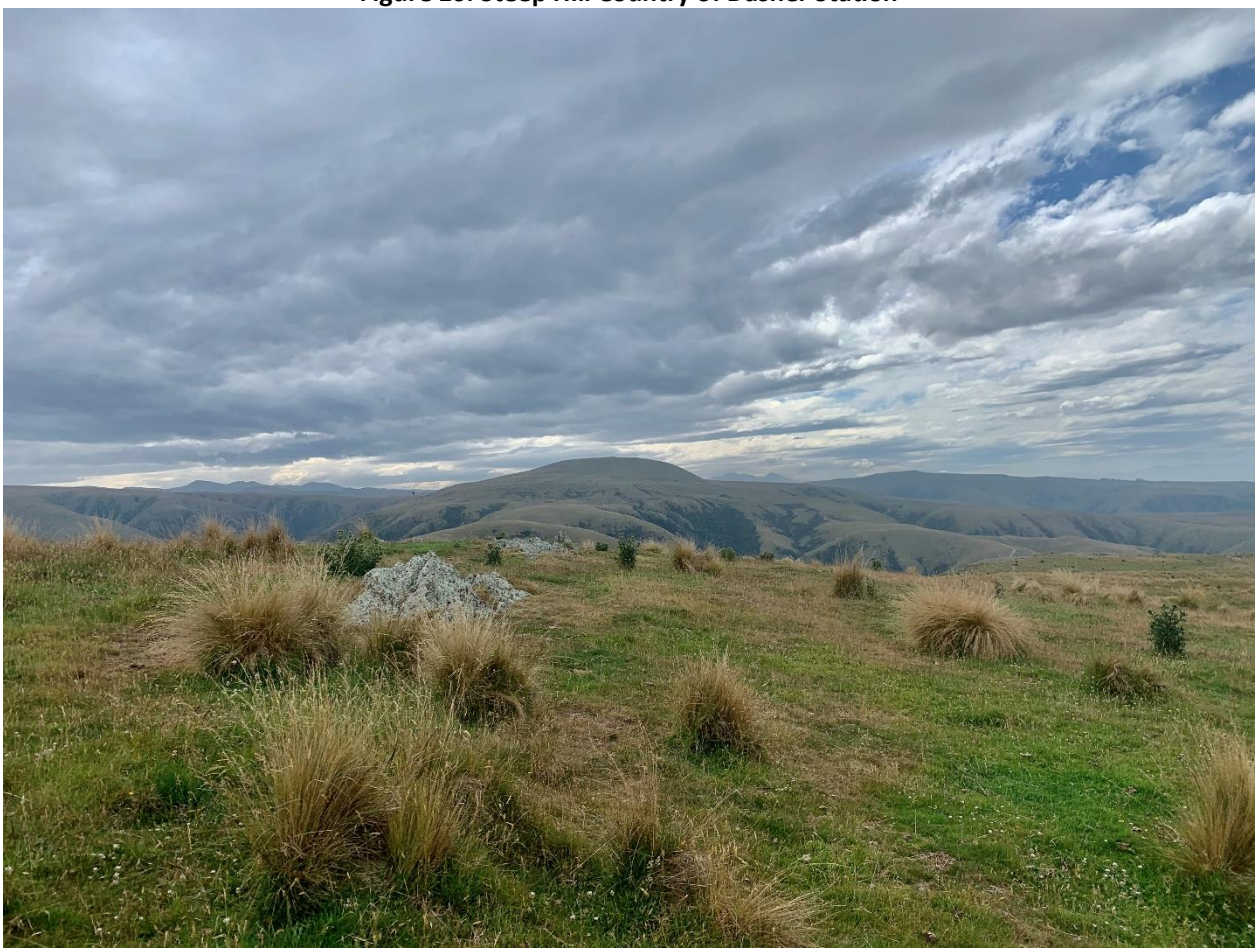


Figure 10. Steep Hill accounts for the majority of land on Dasher Station. January 2020.

The McNaughton's aim to finish 80% of lambs in their good years, although this is heavily dependent on rainfall and subsequent grass cover. There have been years where as little as 5% of lambs have been finished on-farm. Grant is extremely aware of the DM demand of his livestock, which he uses to decide whether to keep lambs to finish or sell as stores. He knows that if he cannot meet the DM demand early in the season, it is unlikely he will meet it later on. With this knowledge, he can select lambs that are best suited to the current market to sell. At the time I was visiting (late January 2020) the DM demand was 29kg of DM per day, which was struggling to be met. But a good growing season further south meant that there was a good demand and therefore good price for store lambs. With only 200 lambs fit for slaughter at the time, 1200 lambs at 33-39kg were pulled out to be sold into the store market. This led to the DM demand dropping by 4.4kg per day, which at the time, was much more achievable.

Post-weaning, all ewes are sent back out onto the hill country to winter where they will be left to regain body condition prior to tupping. Any light ewes are drafted off and given priority grazing, following the lamb's rotation. The lambs are all mobbed as they are usually grouped by replacement ewe lambs, wether lambs and lambs from terminal sires. Paddocks are stocked according to forage cover and lamb numbers, which can then be rotationally grazed. Ideally, the lambs will be put on to paddocks with 2000kgDM, getting the first pickings. They are followed by the light ewes, who will graze the paddocks down to a residual of around 1200kg DM. Grant aims to maintain a residual of at least 1000kg DM. After a few weeks, the wether and terminal sire lambs are sorted again and mobbed dependant on weight.

- Lambs over 36.5kg are kept on prime pasture to finish in the following weeks.
- Lambs 29.5kg – 36kg are drafted out and sold as stores to private buyers
- Lambs 24kg – 30kg are put into mobs to go back out to graze. They will then either be sold as stores or finished, dependant on the markets and grass cover.
- Lambs under 24kg are given priority grazing to maximise growth potential.

The aim is for all lambs to be away from the farm by the 10th of April (mid-autumn) to allow grassland to rest prior to being set-stocked for lambing.

Unlike other farms/stations that I visited, Dasher Station does not have a set amount of land re-seeded each year. Instead, the poorest paddocks are identified (e.g. high amounts of weed grasses, grasses going to seed) and earmarked as potentials to be cropped. They are soil tested and planted into a forage crop that is used to feed in-lamb ewes, prior to being set-stocked for lambing. Ideally these paddocks will be cropped for 2 years, although some only manage a year. Afterwards, the paddock is established as a ryegrass ley, with small amounts of clover and plantain in the mixture. With the majority of lambs being sold off-farm as stores, it is felt that the cost of establishing and maintaining clover would not be returned, so clover levels in the mixtures are minimal. Lucerne is also grown as a silage crop that is baled and fed out over the winter months.

Figure 11. Lucerne Crop

Figure 11. Lucerne crops grown on the farm. These is usually baled and preserved to feed out over winter, although is sometimes grazed by lambs to finish for slaughter.

At Dasher Station, pasture is the cheapest and most efficient way to meet the business aims of maximised weaning percentage and lamb growth weights. The grazing management is considered to be key to maintaining the grassland and achieving this - "*If you manage crap grass well enough you can still improve it!"* (Grant McNaughton, 2020).

Figure 12. Grant's rule of 1,2,4

<u>1 2 3 Rule</u>

1% of liveweight in DM = Survival
2% of liveweight in DM = Maintenance
3% of liveweight in DM = Liveweight Gain

Figure 12. The higher the % of liveweight gain in DM, the better the results

6.6. Ben Annand – Clinton, South Island

Victor and Amy Blaikie farm 1468 hectares of rolling to steep hill country, with plenty of sharp gullies and natural waterways. Of the entire property, 970 hectares are classed as 'effective' with the remaining being either native forestry/bushland or exotic forestry. The farm has been in the family since 1960 and had just one fence across it, with no buildings, roads or amenities. Today, the farm is divided into 49 paddocks, 4 hill blocks and 2 forestry blocks. The paddocks contain a mixture of red and white clover, cocksfoot and ryegrasses. The hill blocks are native tussock and cocksfoot, but have also been sown over with clovers. There are 6150 ewes and 320 cattle at present, which may vary slightly from year to year dependant on grazing availability.

Figure 13. Ben Annand Property map

Each year around 250 hectares of forage crop are grown, which allows hoggets and ewes carrying singles to be wintered on. This is a stark contrast to other farms I visited, where the twins are wintered on the forage crops, but here the grassland is deemed to be of higher quality and therefore more suitable for ewes carrying twins.

Figure 14. Forage crops, Ben Annand 1984

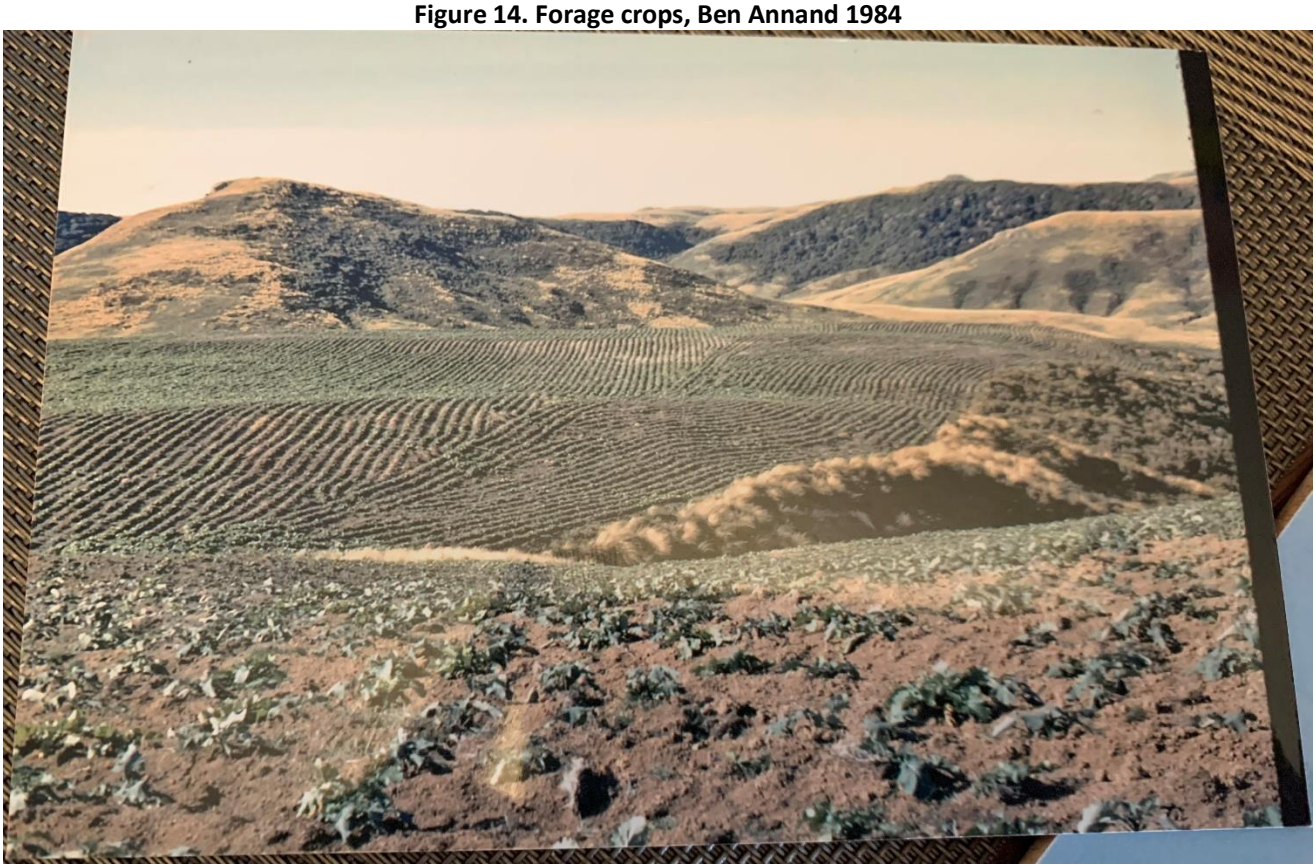
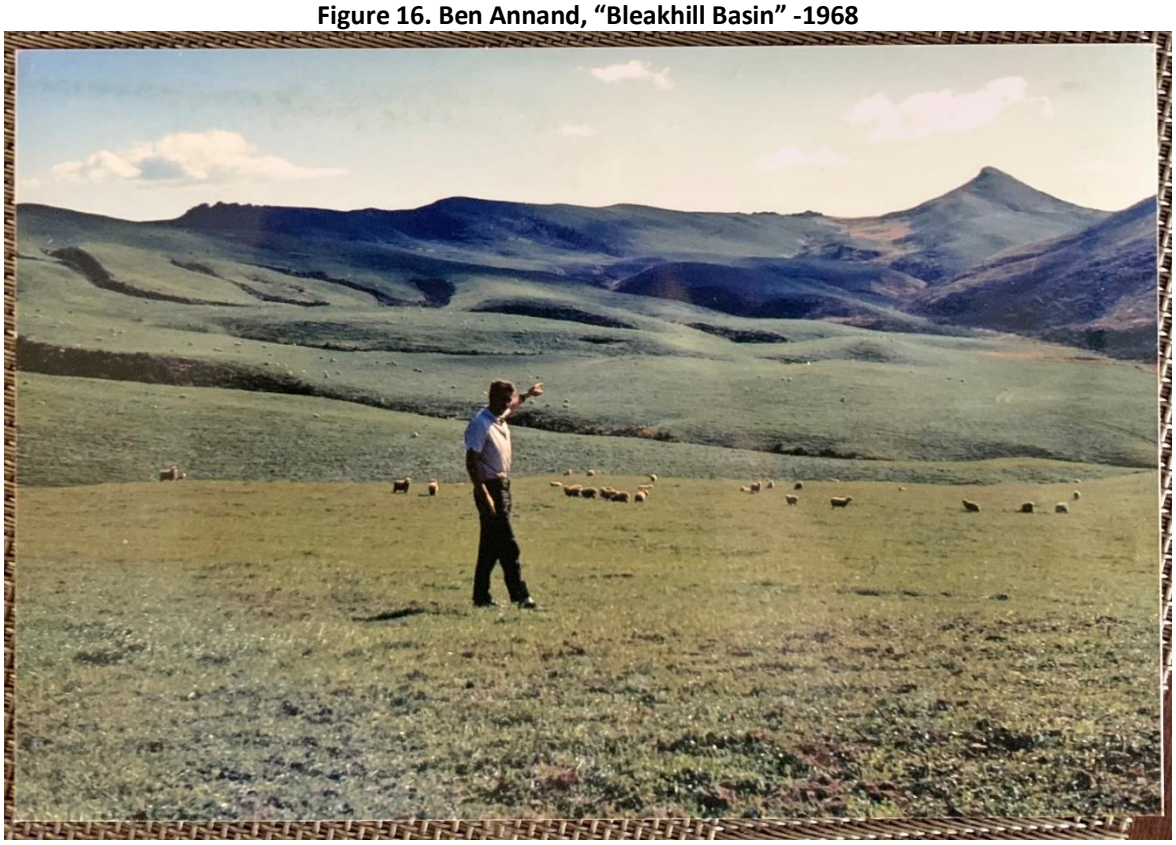


Figure 14. This photo shows an area of land that has been ploughed up and planted with a forage crop. Prior to this, the land will have been rough grazing land that had never been worked. The majority of it would have been covered by invasive gorse bush, reducing the productivity further as the gorse outcompetes native grasses that can be grazed.

Figure 15. "The Chimney Basin" 1968, Ben Annand

Figure 15. This photo shows the grassland prior to it being overgrown with invasive species such as gorse bushes. Livestock will not graze the gorse, and so the productivity of the land is vastly reduced by its presence.

Figure 16. Ben Annand, "Bleakhill Basin" -1968



There is a large variation in finished lambs and store lambs year-to-year. The feed availability and market price dictate what percentage of lambs are finished on-farm. Again, grazing management is key to maximising performance and profits. The lambs are priority fed and are rotated on the highest quality grass and clover leys. In the rotation they are followed by older and lighter ewes, then suckler cows. Any cattle close to finishing are grazed alongside the lambs to finish them quickly.

Figure 17. Ben Annand, January 2020

Figure 17. This photograph shows areas of rough hill that have been overrun with invasive gorse

6.7. Waikaka Genetics – Waikaka, South Island

Ross and Steph Paterson farm 730 hectares (630 effective) of flat to rolling country, wintering around 5250 sheep and 400 cattle each year. Here, all of the effective land is cultivatable, so each year 50-60 hectares of brassica crops are put in, before being put into new grass the following year. The brassica crops are grazed by the in-lamb ewes over winter.

Figure 18. Flat grazing leys of Waikaka.

Each year, 10 paddocks across the farm are soil tested, with fertilisers then being applied accordingly. This is a fairly new practice, with Ross keen to investigate the economic viability of soil testing further. He believes that by having a better understanding of the soil health, he will be able to reduce his reliance on chemicals to control weeds, by achieving and maintaining ideal soil conditions for his desired species.

Figure 19. Unimproved grassland

From weaning, the lambs are mobbed and put onto set rotational grazing. The ewes and cattle are grazed according to the growth that year, with cattle being put onto tall 'stemmier' pastures to get them down, before following the rotation of the ewes and lambs. Here at Waikaka, the biggest factor affecting grazing quality is the stock rotations. Having the cattle grazing the same rotations ensure that grass never has the chance to go 'rank', maintaining fresh growth year-round for the sheep.

7.0. Discussion

Whilst most UK sheep farmers will admit that their grassland has more potential than is currently utilised, this report has shown that to do so does not require expensive input. There is an increasingly uncertain future for British agriculture, with the risk of 'no-deal' trade negotiations with both the EU and the US looking increasingly likely. Furthermore, we are on the brink of a recession following the Covid-19 pandemic. Both these factors highlight the need for farmers to manage the risk to their business. For many, this will mean finding a way to reduce input costs to improve margins. This needs to be done in a way that doesn't significantly deplete production, although it is important that improving margins is focused on, rather than improving yields.

Up until 1984, NZ agriculture was subsidised in a similar way to British agriculture, but this disappeared almost overnight when the NZ government was faced with a budgeting crisis. Yet, NZ are today producing sheep meat products to high standards. Their environmental standards are arguably as high too. It can be pointed out that NZ's economy is much more reliant on the agricultural industry than the UK's is. NZ agriculture produces enough food for 40 million people, without much of a domestic market for much of it, having a population of just 4.6 million. In comparison, the UK is a net exporter of sheepmeat, but only marginally. This is usually done to balance seasonal supply, to balance carcass utilisation, and as a result of economic opportunities available to importers and exporters. The UK currently has a fine balance with lamb and mutton exports, imports, and domestic consumption (NSA, 2020). Whilst it is unlikely that British agriculture will face a drastic shift in import/export balance, a lot can be learnt from the resilience displayed.

7.1. Grazing Management

All of the NZ farms visited and reported on emphasised the importance of grazing management, with the majority stating that it is their primary tool for maintaining pasture efficiency. All the farms visited moved their livestock dependant on pasture cover, allowing over-grazing and under-grazing to be prevented. The main method used by all farms visited was trying to match feed supply to livestock demand. For example, most farms allowed lambs to graze pastures first, followed by light ewes, then the main mob and finally cattle. This gave lambs access to priority grazing, encouraging increased growth rates and reduced days to slaughter. The grazing management undertaken is predominantly rotational grazing, with regular monitoring of grass covers carried out to assist management. It seems that here in the UK, farmers are paying more and more attention to their grazing management, with 'traditional' set stocking practices declining. Rotational grazing is known to be able to increase pasture production, and there are also numerous studies highlighting the benefits to internal parasite control in livestock using this method. (Morgan *et al.,* 2012). Many of the farms opted for integrating other livestock species (predominately cattle) to rotate the parasite pasture burden and control infection rates further.
Reseeding was used on a number of farms to improve grass yields and pasture quality, but at a cost. A cheaper option (and therefore more popular choice) was to renew existing swards by over-seeding. Many farmers incorporated forage crops, mixed swards and/or legumes. Improved feed quality from these swards allowed lambs to finish faster off grass. On one farm they used this high-quality feed for their triplet and twin bearing ewes, to avoid the need for additional concentrates prelambing. In addition, diverse swards further enhance the water holding capacity of the soil, increasing drought resilience. Despite the benefits, it needs to be stressed that without the infrastructure in place, these practices are difficult to adopt. Fencing, water access, access to handling/gathering areas are all things that need to be considered before incorporating these strategies. The set-up costs and maintenance of infrastructure also need to be judged.

7.2. Regenerative Agriculture

The importance of soil health is also being more actively discussed, with it regularly being a hot topic in discussions across agricultural social platforms. Interestingly, understanding a farm's soil profile seems to be much more common in NZ. Good pasture management ultimately leads to healthier soils. Characteristics of healthy soils include drought tolerance, improved water infiltration, nutrient retention, reduced soil erosion and increased plant production. This will also play a large part in the National Farmers Union's push for net zero carbon emissions by 2040 (in line with government targets of net zero by 2050), with pushes for animal agriculture in particular to head towards carbon neutrality. It is well known that well managed grazing equates to healthy soils, which then become carbon sinks. One third of the UK's soil organic carbon is found in the uplands. Adopting rotational grazing strategies can increase carbon capture in the soil and surface biomass,

aiming to reduce the current trend of atmospheric accumulation. Rotational grazing practices have also been shown to increase biodiversity, enriches soils, and enhances ecosystems.

So, what does this mean for UK agriculture? The combination of needing to reduce risk in our farm businesses, and the push for more environmentally friendly farming practices means that soon we will be forced to produce more from our pasture, without having a detrimental effect on our ecosystems. This is absolutely an achievable target, with the right pasture management and mindset.

8.0. Conclusion

Like the UK, New Zealand has an extremely diverse agricultural sector, with many different systems being run across the country. Average holding sizes are fairly similar in both countries too, with the average size of New Zealand farms being 252 hectares and the average size of farms in the UK at 213 hectares. So, the principles of agriculture should be fairly similar, yes?

There are obviously countless factors that can affect the productivity of permanent pasture. But contrary to popular opinion, reseeding is not always the best way to increase productivity. Reseeding is always an option, but it is by far the most expensive one, and there are plenty of other avenues to explore first. Throughout my trip and talking to UK farmers, I was constantly told that grazing strategy is the single most important tool used on-farm, to maximise permanent pasture potential.

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