LAND DEVELOPMENT
AND
PASTURE/CROP UTILISATION ON MARGINAL LAND

A REPORT BY
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Contents

1.0	Introduction	page 3
2.0	background	page 3
3.0	Key findings	page 7
4.0	Why and Where	page 8
4.1	New Zealand	page 8
4.2	Ireland	page 9
4.3	Places Visited	page 10
5.0	Soil nutrients	page 14
6.0	Benefits of minimum/no tillage pasture establishment	page 20
7.0	Hill development	page 21
7.1	Land use change	page 21
7.2	Why develop land?	Page 22
7.3	Land prices	page 23
7.4	How to develop land	page 23
7.5	The process	page 24
8.0	Preferred Plants/Crops.	page 26
8.1	White clover	page 26
8.2	Red clover	page 26
8.3	Lucerne	page 27
8.4	Plantain	page 27
9.0	Fundamental criteria to development.	Page 29
9.1	Vision	page 29
9.2	Strategy	page 29
9.3	Business and bankability	page 31
9.4	Environmental restrictions	page 31
10.0	Case study – Mount Linton	page 33
11.0	Ireland	page 39
11.1	Origin green	page 42
12.0	Succession	page 43
12.1	Farming Trust	page 43
12.2	Farming company	page 44
12.3	Partnership	page 44
12.4	Equity partnership	page 44
12.5	Share farming	page 45
13.0	Relative to Welsh Agriculture	page 46
14.0	Acknowledgements	page 48

1.0 Introduction

This paper will inform the reader on practices carried out and the techniques used to raise agricultural livestock production on marginal land. It will give an understanding of the reasons why the development and improvement of marginal land is carried out so a higher level of agricultural production meets market demand and increases the wealth of farmers.

2.0 Background

My name is James Powell and I was born and brought up in Llanbadarn Fynydd, the northern most village in the old county of Radnorshire, now a part of Powys. The village is almost directly in the centre of Wales, and sprawls the A483 trunk road which runs from Chester in the north, right down to Swansea. I am the third generation to farm at Dolygarn, which I farm in partnership with my father and uncle. The farm is 450 acres, of silty loam soils above clay. After leaving school in Llandrindod Wells I studied Agriculture in Coleg Powys, Newtown after which I returned home to the farm. Also, whenever possible, I worked out and about to experience what else agriculture and indeed, other industries had to offer. I spent four months travelling Australia in 2001-2 and in 2003 I was awarded a YFC Discovery Programme scholarship to travel to Kenya, throughout where I was hosted by different and sometimes very

remote native farms and gave talks in schools, colleges and farming groups on our agricultural practices in the Western society and the cultural differences, the scholarship lasted a month, but I stayed for three, and independently travelled throughout Uganda, Tanzania, Zanzibar, Zambia, Zimbabwe and South Africa.

It made such an impact on my life, that upon returning home, I raised funds through holding fund raisers, local dances and kind donations from the public, I returned to Kenya in 2005 and used those funds to set up some agricultural projects within some of the most remote schools in rural Kenya, including sourcing and supplying bee hives for schools for easy cheap food energy in harvesting the honey, sheep for breeding for an agricultural college and even concreting a schools floor that was on earth and infested with mites.

It was this inquisitive nature and willing to try new and exciting things that gave me the drive to apply for a HCC Meat Promotion Wales Scholarship.

My home farm, Dolygarn is made up of two sides of a narrow valley, formed in the Ice age, split by the river Ithon, (and in modern times, also the A483) the one side with the homestead facing South East, steadily sloping from 1000ft to 1400ft above sea level (asl), the other side is very steep faced, then a relatively consistent 1200ft to 1400ft asl, facing North West. This side is a lot drier, less clay, therefore freer draining and potentially more productive land than the other.

However, it has always begrudged me that a small proportion (as it rises from the road/river) of our most productive ground is so steep it is virtually ungrazable due to its growth of native wild species of fern, gorse and unpalatable grasses, these have overrun anything remotely palatable over time as the topography is unfavourable by the livestock and also unpassable by any land based machinery.

This has led to the under-utilization, reduced natural fertilization and total palatable resistance by livestock resulting in its reversion to its natural state of cover and is a key physical proof that land not receiving adequate nutrients, utilization and management will soon revert to an unproductive state with no financial gain to the business.

However, this does have one advantage, this land could well be seen as a perfect habitat for wildlife.

Through Wales' new environmental protection scheme, Glastir, this land, (through our own admission into application) is now classed as 'no input' which rewards the business financially to leave the land as it is, with no inputs in terms of fertilizers, or any mechanical intervention. Which currently suits the business as any such intervention would be dangerous or expensive.

This got me thinking about the times of our fathers and forefathers, when this land was virgin and was to be brought into production for the first time, the small single furrow plough being pulled by horse or by the first tractors. And

the revolutionary techniques and advances the land has witnessed since.

I found it fascinating that this is still going on today elsewhere in the world, and after some research I was intrigued in how New Zealand are making huge progress in hill development and the huge strides being made in the gains in livestock production from the pastures and forage crops. I wanted to follow the whole process through, into the actual utilization of the new and exciting lands.

Also, I knew that Ireland have adopted grazing strategies learnt in New Zealand, that have revolutionized their industries' grass and crop management and utilization.

It was time to see for myself…

3.0 Key Findings.

- Soil fertility is vital.
- There is a lot we can do in Wales to develop land and a lot of techniques we can use.
- We must learn how to fully utilize pasture, the most economic feed available in most parts of our country
- Work is being carried out to identify and improve more feed conversion-efficient animals.
- There is opportunity to improve beef cattle and sheep efficiencies (weaned weight/maternal weight) In 25 years, NZ has achieved 86% and climbing faster.
- Developing your own land into higher production is a lot more cost effective than buying more land.
- Other countries do a lot more finishing from pasture than we see in Wales.
- In many other countries, different areas focus primarily on what they can do well.
- Rotational grazing grows more grass, of a higher quality, and faster.
- Get the SOIL right, then the PLANT, then the ANIMAL. That order.
- Development of pastures takes place in three stages; subdivision, soil fertility and suitable pasture species.
- In New Zealand pasture production is focused on White Clover as the key species as it supplies nitrogen to the sward and high quality feed when

most needed to drive lamb growth.

4.0 Why and Where?

4.1 New Zealand.

New Zealand has a goal to increase the value of its exports by 50% by 2025. Its population of 4.5 million people is the limiting factor of a strong domestic market of red meat products. This means a focus on exporting red meat and meat products is essential for a forward thinking sheep industry to progress in the global trade.

I spent the first three weeks traveling the South Island, and my final week was spent in the North Island. I chose to spend my studies predominantly in the South Island as this is where the climate is the most similar to that of my native Welsh homeland.

One hundred and seventy years ago settlers from the UK thought that New Zealand would have a Mediterranean climate as its latitude was the same as Northern Italy, therefore attractively different to the UK. However NZ does not have a moderating influence of a Gulf Stream bringing a mild and moist climate. New Zealand lies in the Roaring Forties with the South Island influenced by the Sub Antarctica Ocean and the Southern Alps. The climate resembles those regions in the Northern Hemisphere that are 10 degrees more to the north. Ceri Lewis, the CEO of one of New Zealand's largest farms grew up in Snowdonia. He says, "The Deep South is much colder than Snowdonia, but not as wet".

The North of the North Island is Sub Tropical, therefore has less relevance to Welsh pastoral farming.

I've also always been fascinated by New Zealand's whole essence as a new but credible country stemming from a history of agricultural development, as a country that has always been so dependent upon its primary industries. Today, pastoral products account for about 60% of New Zealand's export income.

4.2 Ireland

Ireland is a country that I have always regarded similar to that of both Wales and New Zealand, it shares a similar land mass and shares a population of around 4.5 million people each, with Wales at 3.1 million. Ireland is also, obviously being our neighbouring nation, a similar climate and latitude to Wales, being 53.442degrees North, 6.2675 West.

Ireland has also always been a nation of people that are willing to change and adapt to fulfill market demands, both at home and abroad, in agriculture, over recent years I have been very aware of the amount of research that takes place there especially in the area of low cost meat and milk production centred on pasture based systems.

On my study tour I visited various farmers but spent most of my time looking at the grass and clover trials at Teagasc, Clonakilty and the sheep trials at Athenry. Irish Agriculture is currently undergoing some serious and exciting new movements that I envisage will make it a very respectable player in future global agriculture.

4.3 Places Visited

Duncan Thomas, H&T Agronomics

Mike & Mel Poulton

Sully & Katie Allsop

Dean Syme

Murray Rohloff

Newhaven Perendales

Mount Linton

Twin Farm, Gore

Peter Desborough
Rex Dolby
Abacus Bio

I landed in Christchurch on 3rd November 2014. Around Christchurch I visited Dean Syme in Darfield, his family enterprise is a mixed farm, growing clover seed and 1700 romney ewes, lambing early to sell from 10 weeks plus, to catch the export UK Christmas lamb trade highs. I also visited Duncan in Oxford, farming 500 acres of marginal land 1000ft plus above sea level. He farms 1600 ewes and 11 cows on 500 acres, 250 of which he has developed from thick and dense gorse and Manuka. His method was to spray with Glyphosate by helicopter (more accurate than aeroplane). He would set fire to the gorse and Manuka. Then would disc with large heavy discs, and finally

either sow sward on direct or would plough to turn the soil over, and then sow the new sward.

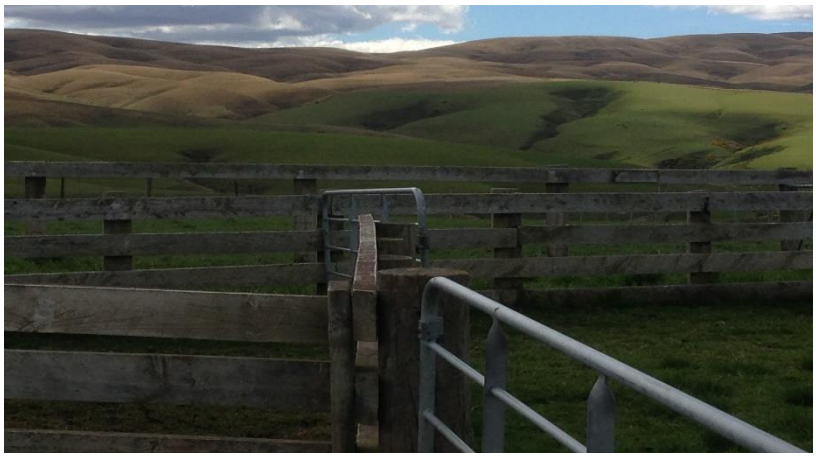
Debris of Manuka roots Year 1 post development

I then travelled down to Five Forks, outside Oamaru, to see Blair and Jane Smith, who along with Jane's parents, Dave and Ros, run Newhaven Perendales. Blair and Jane had bought an under developed hill block of 2700 acres in 2007. They are busy fencing off water gulley's for habitat and damming waterways to stay ahead of the future environmental restrictions they see will soon be coming into place as a result of the country's dairy industry's dependency on Nitrogen, which has ultimately seen a run off, getting into the watercourses.

This is tough Tussock country and their method of development is to aerially spray Glyphosate, then pass over with a tractor with a big set of discs to break up the root structure of the Tussock. Sow swedes or turnips, graze through winter, which enables self-fertilisation and further breaks down the soils. The second year they would glyphosate, then disc, then sow a long term grass ley with a white clover included in blend.

Next I spent several fascinating days based from Dunedin with Peter Desborough, an independent pasture consultant specialising in hill development and the further utilization of sward species, we travelled throughout Otago and surrounding areas looking at the varying work he was doing with clients throughout all agricultural sectors and the different methods he trials and conclusions arisen.

Whilst in Dunedin I also spent a few days with Abacus Bio, world leaders in all things agricultural consultancy, with departments in animal genetics, beef, dairy, sheep, grazing and research, I was lucky enough to spend a day with a crew from Abacus Bio on the new CPT (Central Progeny Test) site on Onslow View, here all the Rams with superior genetic traits are mated with ewes and measured at extreme hill country altitude in order to identify the genetics of the absolute highest performing animals. The lambs are born outdoors, 2500ft above sea level, in tussock country, The crew and myself were tailing the new lamb crop, taking DNA samples for parentage and EID tagging all lambs. Onslow View is the new High Hill Country farm brought into the CPT and is under its own development programme.



Onslow View Hill Development. Foreground developed. Background

undeveloped tussock country.

I was very fortunate whilst in Dunedin to have the pleasure of meeting Dr Rex Dolby and having the honour of his and his wife's hospitality at his home. Rex is a retired soil scientist who was instrumental in worldwide developments in understanding soil fertility and its implications through the plant and furthermore into the animal through trace element uptake.

I travelled to Gore to see Russell, Pam and Andrew Welsh and their farm, the renowned Twin Farm Genetics and the fantastic stock they are producing, the Tefrom, a composite made up of Texel, East Friesland and Romney genetics and also their suftex flock which are also all involved in the CPT and are gaining momentum fast as a leading meat yield, quick growing and proven CPT regular top 5% sire, both maternally and as a terminal in the Suftex. They run 4500 ewes that rear am average of 5750 lambs and sell on average around 500 stud rams each year and 1300 ewe lambs. They farm 1800 acres at 500ft asl.

They grow fodder beet which has seen a huge surge in New Zealand as the yield is so high, barley and swedes for the livestock. Though it is a nice lowland area, it does come with its weather challenges halting grass growth in winter months of May, June and July.

Next I visited Mount Linton, which was perhaps the most relevant to Wales' climate although it must be noted it's in such a larger scale, I have gone into a lot more detail in my case study in later pages.

I was lucky enough to get the opportunity to visit and spend a great deal of

time with Murray Rohloff, one of New Zealand's most highly respected Romney stud breeder and international sheep consultant, it was perhaps my meetings with Murray at his previous talks in the UK and his vision and knowledge of sheep and his willingness to help that I even travelled to New Zealand. He organised many contacts for me on my travels and was instrumental in the understanding of finer details. And for that I will be eternally thankful.

I flew over to the North Island for the final week of the scholarship.

I stayed with Mike and Mel Poulton at Wairiri Station, Kumeroa, Woodville. The station is 2500 acres of steep hill country running 4000 Perendale/Finn/Texel composite ewes. Mike also sells 30 stud rams a year and it is a true joy to see the strength in his sheep bounding up and down the farms unpassable terrain. Mikes own hill development programme starts with sub division into manageable block sizes and bulldozing tracks into the near vertical slopes, for quad access. The natural health and strength in the livestock on Mike and Mels farm was one of the highlights of my trip.

Mel Poulton also works as the Extension Manager at Beef and Lamb New Zealand (NZ's HCC) and I spent some time with the staff learning of the future markets for NZ's beef and lamb industry going forward.

I was also introduced to Duncan Thomas who is an agronomist with H&T agronomics, a company that are immensely progressive and a big part of the success of new crops like plantain in NZ. I spent a day with Duncan and travelled around many, many, farms as an add on in his busy working day

advising his many clients on crop management and establishment, a forward thinking company with a big future.

Lastly, I spent a day with Sully Alsop, in Masterton. Sully is a consultant with Baker and Associates, a big name in consultancy in all agricultural fields. Sully also farms in his own right, run by his wife, Katie. They run some 2000 ewes on land owned, and some in an Equity Partnership with a couple of City Lawyers who bought the land, the owners are 80% owners of the business, Sully and Katie hold 20%, they hold meetings every 3 years whereby Sully and Katie have an option to buy more into the business, depending on performance, gaining equity. It is a popular choice for young new entrants into agriculture in NZ and has been proven by the success of many a farmer through this entry.

Sully and Katie's own land development has been through chemical topping, sowing plantain and clover and fencing off their hill land, sub dividing it to better manage grazing. Being a damp natured farm, they have also mole ploughed land to remove excess water to further dry out the surface.

5.0 Soil Nutrients

There are 15 essential elements that plants must have in order to grow properly

There are three nutrient elements obtained from atmosphere through photosynthesis

- Hydrogen
- Carbon
- Oxygen

There are 12 nutrient elements obtained from the soil

- Nitrogen
- Phosphorus
- Potassium
- Sulphur
- Magnesium
- Calcium
- Iron
- Boron
- Manganese
- Zinc

- Molybdenum
- Copper

Out of the 15 essential elements that come from the soil, we deal with only the 12 that are generally managed by the growers. These 12 elements are mineral nutrient and are obtained from the soil. We further divide mineral nutrients into 3 groups: primary, intermediate, and micronutrients. Also, cobalt, chlorine, and nickel are included by many as essential nutrients.

The primary nutrients are nitrogen, phosphorus and potassium. You may be most familiar with these three nutrients because they are required in larger quantities than other nutrients. These three elements form the basis of the N-P-K label on commercial fertilizer bags. As a result, the management of these nutrients is very important. However, the primary nutrients are no more important than the other essential elements since all essential elements are required for plant growth. Remember that the "Law of the Minimum" tells us that if deficient, any essential nutrient can become the controlling force in crop yield.

The intermediate nutrients are sulphur, magnesium, and calcium. Together, primary and intermediate nutrients are referred to as macro nutrients. Macro nutrients are expressed as a certain percentage of the total plant uptake. Although sulphur, magnesium, and calcium are called intermediate, these elements are not necessarily needed by plants in smaller quantities. In fact, phosphorus is required in the same amount as the intermediate nutrients, despite being a primary nutrient. Phosphorus is referred to as a primary

nutrient because of the high frequency of soils that are deficient of this nutrient, rather than the amount of phosphorus that plants actually use for growth.

The remaining essential elements are the micronutrients and are required in very small quantities. In comparison with macro nutrients, the uptake of micronutrients is expressed in parts per million (ppm, where 10,000 ppm = 1.0%), rather than on a percentage basis. Again, this does not infer that micronutrients are of lesser importance. If any micro nutrient is deficient, the growth of the entire plant will not reach maximum yield (Law of the Minimum).

Since the soil provides most essential nutrients, it is crucial that we understand the soil processes that determine the availability of each essential nutrient for plant uptake.

Soil Organic Carbon is a measure of of the carbon contained within soil organic matter. Continuous pasture builds organic carbon quicker than other rotations. Erosion events remove topsoil which contains the bulk of a soil organic matter, taking years of good management to replace.

Microorganism's breakdown SOC as an energy source, this occurs faster when the soil is moist and warm. SOC is right at the top of the criteria for soil fertility and health. As a result of microbial decomposition activity it supplies plants with many essential nutrients including Nitrogen. So the greater the amount of SOC the greater the number and diversity of soil inhabitants (worms etc) it can support. It is this life beneath the surface that shapes the whole soil structure, the soil=s natural ability to suppress disease and its ability to buffer harmful and toxic substances. SOC is a measurable component of Soil Organic Matter.

Soil Organic Matter SOM is mainly composed of carbon, hydrogen and oxygen. It is divided into living and dead components and ranges from very recent inputs such as stubble to largely decayed materials that are thousands of years old.

6.0 Benefits of minimum/no tillage pasture establishment

- Greatly reduces costs of renewing pastures.
- Reduces time the area is out of production compared to ploughing, working down etc.
- Retains microbial activity, worms etc, exposed to predators after ploughing.
- Encourages Mycorrhizal Fungi, which improves aggregate stability
- Builds soil carbon
- Improves water use efficiency
- Increases efficiency of Nitrogen, phosphorous and Sulphur

7.0 Hill Development, New Zealand.

7.1 Land Use Change

New Zealand has in the last 10 to 15 years undergone unprecedented land use change, as the countries Dairy sector has taken off, largely due to Fonterra, a farmer owned co-operative whose main product is milk powder for export.

Most of its product goes to the expanding population and also wealth of Asia and of course, the phenomenal steam train of global powers that is China to feed the growing markets as the Chinese people are seeing their wealth grow, they are increasingly stretching their food pallet especially turning to Western foods and indeed any foods not previously experienced in their ex-communist culture. The milk powder is easier and cheaper to transport and is used in infant milk formulas, chocolate, sauces to name but a few.

This has seen an explosion of grass based Dairy farms all over New Zealand, displacing many sheep farms as dairying is widely renowned to have a tenfold income to that of sheep farming, in terms of $ per ha. However, top sheep farmers have equaled Return On Capital. Milk from pasture is also a more regular income and regarded as more efficient in turning grass into income. The higher income from dairying allowing farm succession to be more easily managed, has been a big attraction to former sheep farming families.

7.2 Why develop land?

With the huge uptake of the dairy industry, the expansion of the agricultural land utilized for dairying expanded out into many other sectors, the dairy farm would utilize all its own land for the grazing of its cows so would often contract out all its silage or fodder production to another farmer.

Also the dairy farm would need replacement heifers to replenish the herd so having bred the heifers out of his own cows, yet utilizing all his own land for the milking cows, he would pay another farm to rear the heifers on liveweight contracts until they are at the point of calving, at which point the heifers re-enter the dairy farm. These are known as Dairy support farms, and a huge proportion of these formerly would have run sheep, or buy store lambs from the more upland or hill country farms to finish. There is a support farm for every milking platform dairy farm.

This has all led to the sheep farms being more concentrated into hill country as the financial returns off the land through sheep production in relation to the land value is more relative in the higher country. New Zealand is no different to most other temperate regions where sheep become the default land use option.

With the land loss to dairying, New Zealand sheep farmers are forced to improve their hill pastures as much of the traditional finishing land is now

converted to dairying and dairy support.

7.3 Land Prices (as at 2014)

$3000 - $6000/Ha	(£1500 -£3000/Ha)	Hard Hill Country
$6000 - $20,000/Ha	(£3000 -£10,000/Ha)	Rolling Hill Country
$10,000 - $60,000/Ha	(£5000 - £30,000/Ha)	Flat Country

7.4 How to Develop?

One of the most interesting discoveries on my travels in New Zealand were the varieties of methods of developing land, which I will refer to later, but the one thing every method relied upon was right at the start of any development plans, and it begins right at the bottom, below the ground, in the SOIL.

The start of any project is to know and understand your soil fertility. Get the soil fertility right and whatever is chosen to be planted has the optimum opportunity of maximum growth.

In depth soil testing is key to understanding what is excessive or deficient, enabling farmers to re-balance the soil. Regular visual assessments of the soil

and plants should also be carried out and recorded. If you get the soil fertility levels lifted to adequate levels, pastures will be more easily established and persist with high production. Most developed hill country pastures produce more than 80% of those grown on the flat.

7.5 The Process

A lot of farmers in New Zealand are still using the plough to cultivate new and more expensive forages and crops like fodder beet etc, which I suppose is a way to guarantee the highest yields for the most cost effective returns on easier worked ground. But far and away the most popular method of rejuvenating or reseeding is minimum or no tillage.

This is done by first spraying the area with glyphosate, (it seems as though glyphosate is the staple of New Zealand. It is used in so many situations, it is used in ditches to prevent them filling with weeds etc, farmyards to stop weeds and grasses taking over idle corners etc etc, it is commonly sold in 1000litre IBC's). It has huge usage in the field and on many occasions the area is sprayed off twice, two or three weeks apart. This is either done by tractor sprayer or more widely, aerially, either a fixed wing plane or a helicopter for more refined, accurate coverage.

Depending on the previous foliage it would now be disced with big sets of tractor discs, if it was previously in tussocks, or set fire to and burnt off it was in gorse, and then disced. The discs serve to break and slice the weed roots, to

expose the soil and loosen the top soil surface ready for a seedbed which is vital that the seed contacts with the soil. Discing also leaves the soil A horizon (organic layer) on top instead of burying it under lower fertility sub soil.

The seeds are sown, again, on more challenging terrain, with a fixed wing plane, or a helicopter. This aerial spraying/sowing/fertilizing costs approximately $1200 per hour (£600). However, in one hour the area covered is around 40 Ha (100 acres), making it around ,6 per acre. Pretty quick and efficient over larger areas once the cost is broken down. Also for the safety aspect as some of the topography can be dangerous on a tractor or completely unpassable.

The seed is then predominantly trodden in to ensure a good seed to soil contact. This done mostly by large flocks of sheep, anywhere between one and two thousand head. This is called "hoof and tooth" as the sheep have small feet and act as an ideal press to push the seed into the seedbed, this may be done by a shepherd and his dog running the sheep throughout the area or just very heavily stocked and left for a period of time.

If the farmer wants to cut costs further he may put the seeds in immediately after the glyphosate and as the existing foliage is dying off, it will be grazed (from 5 day's post glyphosate), thus trampling in the seed as the sheep graze the dying grasses, the sheep find this palatable as the sugars in the plant get trapped in the leaf to be eaten and as the moisture leaves the plant, the Dry

Matter is a lot higher. This method used to be referred to as “spray and pray” but many farmers nowadays have found that if the soil is tested and all the deficiencies corrected and the correct type of forage crop/grasses sown, it is an incredibly cost effective option of improving land, it has huge benefits on steeper slopes where too hazardous for tractor or any sort of vehicular access.

8.0 Preferred Plants/Crops.

8.1 White Clover.

This species is the basis of all New Zealand’s pastoral farming. All management is based on maximizing clover production as clover feeds the nitrogen cycle supplying over 200kgs of N to the entire pasture. This is an essential part of farmers' reseed mixtures. It has one of the highest digestibility values of any grassland species, and thrives under low nitrogen fertilizer inputs.

Applications of over 100kgs of N are seriously detrimental to white clover, as it encourages grasses to over-top clovers robbing them of essential light needed to produce carbohydrates that also feed the rhizobia in exchange for nitrates. The grasses receive their nitrogen boost by grazing animal’s urine spread. Rhizobia in legume root nodules must have sufficient quantities of molybdenum and iron.

8.2 Red Clover.

This is very different from white clover. It is generally only a 2-4 year crop, has very deep roots and grows far taller than white clover. It has the ability to fix double the amount of nitrogen that white clover does, anywhere between 200-300kgs/Ha. A lot of people who grow red clover tend to cut it a couple of times and then graze it thereafter. Caution needs to be used when grazing, firstly because of the risk of bloat and secondly because of the high levels of Formononetin which breaks down in the rumen to become a potent phyto-oestrogen affecting the reproduction of post pubescent ewes. Red clover is included in most pasture seed mixes at about half the plant rate of White Clover.

8.3 Lucerne.

In New Zealand was widely used to finish lambs as part of a mixed sward, it has a very deep tap root and again fixes large amounts of nitrogen, around 250kgs/Ha, it grows well in soils with a PH anywhere between 6-8, but in its establishment phase it requires trace elements in the soil. On some of the farms I visited they were able to grow anywhere from 10T/DM/Ha to 17T/DM/Ha. Lucerne is very specific to recent and well draining soils. It is very sensitive to Aluminium toxicity so very common throughout the UK in upland soils of sandstone origin.

8.4 Plantain.

This is a mineral-rich grazing herb that is high in protein. It contains quite high levels of calcium, magnesium, phosphorous, sodium, zinc, copper and cobalt, and the animal's ability to retain copper, sodium and magnesium is higher when on plantain than when on grass. It was interesting to hear farmers claim that the plantain was often the first plant that animals grazed. Plantain has a deep fibrous root system which puts a lot of tools in its tool box, and is particularly good at performing well in lower fertility soils. It also responds well to nitrogen.

Plantain sown via “spray and pray” at over 1000ft asl.

9.0 Fundamental criteria to development.

For any farm to undergo any large development works there is a pattern that occurs, for each and every case I witnessed, I saw the same recurring theme, I have broken this down into four sections which form the backbone and are as vital to the process as each other, these in order are;

9.1 Vision

The farmer must have a vision, whether it is to maximize the utilization of land at home, a desire to expand the current acreage but doesn't want, or can't afford to purchase more land. The farmer might want to run more stock units per Ha on a more intensive system. Maybe the farmer wants to create more free time by improving the quality of pastures thus finishing stock quicker and easier, one farmer I met, was a victim of a family dispute that ultimately left him with only half the farm he previously owned, so found himself having to bring all the poor, untouched side land areas into production just to rear the same stock units as he previously ran on the farm.

9.2 Strategy

The first physical task that must be carried out is sub division, probably the most important part to retain the quality of sward species in any improved land.

The land is fenced into smaller areas, for the control of the weed species to be eradicated, to get the new sward or crop established and to maintain and thrive in its new form, due to grazing pressure. Electric fencing will substitute for more expensive permanent fencing in the early stages, and also better for the control of big mobs if unused to smaller blocks.

Size of the sub division blocks is directly relevant to mob sizes, but the farmer must also take into account the elevation aspects of the land, the topography and whether the land is facing North, East, South or West, and the weather patterns that brings, stock caught on a non-shaded slope in the snow or blowing winds could perish, likewise a sun facing heat trap with no shade could cause heatstroke and dehydration. The water aspects are also to be considered, do the stock have sufficient water to drink in each sub divided plot?

The farmer must also make sure the soil status of the land fits the development, i.e., are the existing weed roots holding together valuable soil structure that could move under mob grazing pressure or weather patterns

that could cause a land slip. Is the soil of a type that will support the growth of the new species? Does it burn off in summer? Does the land become too waterlogged in the winter?

Also, to be considered, must be the lands infrastructure, the roads to and from the parcel of land, in New Zealand's case, the land may need an extra airstrip for planes to land and fill with the lime/fert/chemical spray. This would of course need roads to enable delivery of said products via bulker lorries etc. the land may need some sort of drainage if the rainwater can't get away off the land quick enough. There may be more handling facilities needed as the land may be too far away to move livestock between blocks.

9.3 Business and Bankability

Any bank manager approached to lend the money for any development works, would expect to see a viable business plan as the works will obviously be a costly exercise and will only give a return once the land is several stages into the process. Obviously this would mean analyzing and costing each process of the strategy. The farmer would need to use people's expertise in that person's field, i.e. the vet for an animal health plan, an agronomist or soil scientist for a detailed plan of action for the soils test results, knowledge of soil types, structures etc.

9.4 Environmental Restrictions

Although there are no subsidies directly or in-directly to farmers from the New Zealand government, or any form of environmental or habitat payment schemes It is worth stating now that there are indeed some environmental restrictions to adhere to, in regards to developing Virgin Hill Country in New Zealand, some are as follows;

You cannot develop if 50% or more canopy (taken aerial view) of native Red Tussock in mountainous country, or any areas classified as high value flora for conservation.

You cannot develop land of more than 20 degrees' slope, without appropriate consent from the relevant authorities.

You cannot develop if the proposed development land is above 700 metres (2296.58 ft) above sea level, without the appropriate consent from the relevant authorities.

10. CASE STUDY

MOUNT LINTON STATION, OHAI, SOUTHLAND, NZ

Mount Linton is one of the most Iconic sheep stations in New Zealand. And covering an area of 32000 acres, it is also one of the largest. I spent a day there with the Farm Manager, Ceri Lewis, who personally drove me around the station, we drove around the hill blocks that are currently being developed which in itself, took us three and a half hours, the scale there is awe-inspiring.

It covers some 32000 acres. The station runs 98500 stocking units, made up of 42500 ewes, predominantly their own commercially developed Romtex, (their stabilized cross of Romney x Texel). They also run pure Texel and Sufftex

nucleus flocks, which rear their respective stud rams for sale which are gaining momentum throughout New Zealand and are highly regarded and respected through Mount Lintons involvement in the CPT (Central Progeny Test).

They also run 15000 ewe lambs, 2800 Aberdeen Angus cows and 1200 replacement heifers. They employ just 12 staff over all the sheep and cattle and a further 8 that are employed on the tractor/mechanic/fencing side of the business. They also use 120 dogs which they feed approx 50 sheep carcasses a week.

Hill Development at Mount Linton.

Mount Linton Hill Country 2000ft asl. Native state of Tussock on the flats, and manuka and gorse on sideland.

The Hill Development programme at Mount Linton was the most exciting Id seen anywhere, not only was it the biggest, with the station focused on bringing into a state of maximum production some 300ha per year, all in all at a cost of around $1,000,000 per year, but it was by far the most challenging, with inclined slopes of 30+ degrees, thickly matted with Manuka trees, (prolific and typically a shrub growing to 2 to 5m (7 to 16ft) but can grow into a moderately sized tree, up to 15m (49ft). But it was the development carried out over the longest period of time and was the most strategic, focused and thorough, this all told, made it some of the most successful I'd seen anywhere, also.

Although it is a huge capital investment each year, Ceri Lewis, the Mount Linton Farm Manager has meticulously costed it all out from the inputs to the output, upping the land undergoing development from 100 Ha per year, a few years ago, to 300 Ha per year. Ceri said that pre-development, the land carried 1.5 stock unit/ha, but post development the same land runs between 10 and 12 stock units/Ha. A lift in production from that same land of a huge 8 times more than previous, once the land is fully developed.

It is worth saying firstly that all applications are carried out aerially by aeroplane, Mount Linton Station has THREE of its own airstrips on the farm.

The maintenance fertilizer dressing at Mount Linton is 250kg/Ha RPR (Reactive Phosphate Rock) which is unprocessed Phosphate (P) that takes longer to break down, as its in its unprocessed natural rock format. This is carried out in March.

However, in the process that the ground is under development, as described

below, 1T/Ha (70 units of P) of soluble Phosphate is used as the Phosphate is instantly available into the soil enabling instant benefit of nutrients.

Year 1.

They started by aerially spreading 2.5t/ha of ground lime in preparation, then six months later, another 2.5t/ha of lime, then aerially spraying glyphosate to kill the existing herbage. Two months later, another spraying with glyphosate to take out any leaf that has developed post first kill and anything still growing.

The area would be sown aerially in mid-November with stubble turnips which would then be grazed throughout May through to August. (UK's November to February) by yearling cattle, the land would be sub divided by electric fencing into approximately 1 acre blocks, with 1 weeks break, the cattle would then serve to poach and break up the Manuka trunks (Manuka has a shallow root system) and turn over, cultivating the soil in the process. Also defecating and turning the manure over into the soil, self fertilising the land also. The yearling cattle are weighed and recorded to still grow at a rate of 600-700kg/day over the 120-day winter, grazed in this way.

Permanent sub-division on Hill Block, Pre-development.

Year 2.

Another Glyphosate kill, then sprayed/sown with a swede, Aparima Gold, which is the highest yielding main crop swede, a potential yield of 18,000 kg DM/ha, it has been bred and trialed by Plant & Food Research for NZ grazing systems. Aparima Gold is a hardy, yellow-fleshed bulb with medium maturity that is Clubroot disease and Dry Rot tolerant, with excellent keeping qualities and a high leaf percentage.

They now permanently fence the development area into approximately 50 Ha blocks, this would be done approximately, taking into account topography, water availability etc.

Again, this would be grazed with yearling cattle to further break down any manuka and gorse now dead wood and to fertilize and cultivate the land.

Years 3 and 4.

Again the development begins with an aerial spray of Glyphosate, then sown with an Italian 2-year grass lay, this for the vigorous establishment and high yield. Being a short term lay it’s also early growing, with a long season and high sugar levels. This would now serve two years grazing.

Year 5.

Again, starting with an aerial Glyphosate kill, the area is now layed down in a

permanent pasture, a long term lay with a white clover content.

Post development. Block to left of photo is Manuka land not yet developed.

Post developed land. Hill bock behind in development stage (glyphosate kill).

11.0 Ireland

Teagasc is the agriculture and food development authority in Ireland. Its mission is to support science-based innovation in the agri-food sector and the broader bio economy that will underpin profitability, competitiveness and sustainability. They run a project called the BETTER farms programme which involves applying research-based recommendations to a farming system where the results can be measured and demonstrated at a local level.

The outcome and benefits of such research are evaluated in terms of how practical they are to apply, along with the impact that they may have on the farm business's efficiency and profitability. Research demonstration farms and

BETTER farms are then benchmarked against one another to continue the progress from year to year.

I was fortunate enough to be able to meet a farmer involved in the BETTER farms programme during my time in Ireland and, given our scale advantage in the UK with the opportunity to spread fixed costs over increased output, I would say the potential for improvement in Wales, with modernised grassland management is significant and can be achieved in cost effective ways and quickly.

Brian Nicholson, BETTER FARMS monitor farmer in Kilkenny, runs 1000 ewes on just 120 ha, through rotational grazing. His flock is made up of mules, texel x mules and Belclare (Belclare are Teagascs own composite breed, made up of Finnish Landrace crossed on a Galway, laterly infused with Lleyn also). He has subdivided his larger fields by permanently fencing into two paddocks.

He then rotationally grazes in mobs of 200 ewes plus followers until weaning then rotationally grazes the lambs in larger mobs still, but now with an electric fence to further sub divide grazing, allowing fuller utlisation of the sward, and quicker regrowth of the swards also.

Teagasc Athenry, just outside Galway, run a programme called 'Making the most of grazed grass'. Led by the farm manager, Philip Creighton, at the Sheep Research Demo Farm Athenry. It holds regular demonstration and open days where farmers can see firsthand the work and findings of the research trials.

The study initially tested their soils and found worryingly that only 10% of soils tested are at optimum levels of P, K and Lime. Correction of this resulted in 20% of total variable costs went on fertilizer, noting that effective management ultimately saves money.

Its objective is to develop profitable and sustainable pasture based systems of sheep production. The project is to determine the effects of stocking rate and ewe prolificacy on lamb production from grassland based production systems. This is carried out by looking at stocking rate, prolificacy, grass supply/demand and lamb performance at pasture. Farm manager Philip showed me around and I found the attention to detail was so thorough with the land divided into farmlets of varying sizes and carrying various number of ewes and followers pre-weaning as I was there in May.

The Summary of the ongoing research is that great potential exists to increase the sheep output and income from grass, up to 1195 increase in output, 1395 increase in GM/ha. The Key Areas are growing and utilizing enough grass to support increased output and the setting up and managing the farm to facilitate it. But, the study notes that each farm is different and stresses that ultimately each farmer should know the grass production potential of their own farm.

I also visited Teagasc's Moorepark Dairy Research Farm in Clonakilty, on the South Coast of Ireland. Fergal Coughlan, dairy research Technician showed me around the research work carried out in the Grassland Science department and

the swards and differences in milk yields with varying clover contents.

One project was to identify management strategies to incorporating white clover in swards, measuring the effects of companion grasses and the clover uptakes, along with Nitrogen application effects on sward clover content. One sward in the research programme had a clover content of 80%, from just a 2kg/acre clover inclusion in sward sown, and dominated any companion grasses also in the sward, resulting in detrimental health in the cows through bloat and other stomach issues.

Photo indicates 80% clover dominance in sward resulting from just 2kg/ac clover inclusion.

11.1 Origin Green.

Origin Green is marketed as the new contract with nature. The Origin Green promise is an unprecedented one. It claims to be the only sustainability programme in the world that operates on a national scale, uniting government, the private sector and food producers through Bord Bia, the Irish Food Board. It is an effective marketing tool in which all Irish meat, poultry and dairy

products are united under one umbrella of the green, pure natural image of a low carbon, environment-conscious Ireland.

12.0 Succession.

In a recent poll, 80% of farmers in New Zealand said that farm succession is the greatest difficulty that they see, facing New Zealand farming. Though I was very impressed at every farming business that I visited, at their approach to succession (or more modernly called mobility within farming), the majority of farms are run with a more business-like approach than in the UK.

However, there are very few rented farms in New Zealand as most are owned on freehold titles. Most forward thinking families have a strategy whereby the next generation, should they wish to take the business over, can do so in a manner that leaves both generations and often non farming siblings in a safe financial position, with the responsibility, day to day running and financial burden of the business resting on the shoulders of the younger generation

whilst they are young enough to embrace the challenges with the youth, ambition and drive, only found in that younger generation.

With the basis firmly remaining around ownership entity, and with no inheritance or gift tax in New Zealand, the farming family may set up either:

12.1 Farming Trust.

The farming family would now be beneficiaries of the farm which is now in a trust, this would enable non farming siblings to get a rent or income from the farm off the farming sibling. With the farm in a trust, it protects the land ownership (avoiding matrimonial issues, family disputes etc).

12.2 Farming Company.

This is the common form of land ownership making succession easier. Limited Liability Companies have a capped tax rate of 30%.
Parents may issue shares to their children, the shares equate to value of the farming enterprise minus debt (equity).

12.3 Partnership.

These are more common between husband and wife in New Zealand, but are the most common in UK agriculture, where the next generation would join into

a business partnership with parents and farm alongside. This is widely not seen to give enough responsibility to next generation and can result in all parties paying a higher personal tax rate.

The culture of succession in New Zealand is to make a clean delineation between generations in responsibility. This gives the new generation of management an opportunity to accumulate wealth over their working life.

12.4 Equity partnership.

This I found an interesting agreement, whereby the farmer/landowner partner the youngster, who has borrowed a share, say 25%, he would be paid a salary to run the farm. The land owner pays running costs, maintenance etc. This would be reviewed every 3 years or so and the young man/woman would at this point of review, be given the opportunity to purchase more shares. A popular scenario would be investors purchasing land/farm and new entrant buying shares, increasing his/her shares at review looking to get into land ownership.

12.5 Share Farming.

This is very commonplace in the dairy sector and again, a great way for a new entrant to start farming. There are a few variations such as 29% share-milking, the new entrant would supply labor and running costs, and retain 29% of profits. 50% share milking, the new entrant would provide the cows,

machinery and running costs for a 50% share in profits. The landowner would pay irrigation costs, harvesting, capital improvements, upkeep of infrastructure etc.

13.0 Relative to Welsh Agriculture

Since my return to the farm in Wales, I have looked a lot more closely at the soil structure throughout the whole farm, on a field by field basis.

I have already been since 2011, in the process of soil testing areas of the farm, and addressing any lime requirements with applications of lime. Also the fertilizer regime that I followed on farm, indicated that the land was responding adequately to any Phosphate and Potash requirements addressed quickly.

I am now much more aware and instantly alerted to any visual colour changing

or wear in the leaf of the grass which indicates a deficiency of any nutrient (red tinge – phosphate deficient, yellow tinge and wear to edge of leaf – potash deficient etc).

Our poorest performing fields though, were just dismissed and accepted as being poor. But now I have studied them in more detail, the one in particular, a fourteen-acre field that I had always regarded as being the poorest on the farm, it was limed in 2013 so I knew the ph was above 6.0. It grew a lot of moss on the top half and the bottom half saw water running over the surface regularly after any wet period.

First of all, we corrected any blockages in the drains on the field and jetted them to free them up to ensure they all flowed freely.

I applied glyphosate on the grass at a height of 100mm, left it for five days and then mob grazed it with sheep down as low as possible, less than 40mm. Three weeks later on 6th of June, we direct drilled a Plantain and white clover mix.

This was grazed from early August by weaned lambs and sub divided by an electric fence. Plantain has anthelmintic qualities reducing foecal egg counts and the lambs regular weighing recorded that the lambs were growing the fastest on farm thanks to the high levels of protein and trace elements. By addressing detrimental issues and matching the soil type and fertility to new plant species available, I had turned the poorest performing field into our best

performing field.

I have also direct drilled stubble turnips to extend the winter grazing and also in late August 2015, incorporated an over-sowing technique using a rape and turnip brassica express, with success, reducing establishment costs even further.

My aim going forward is to reduce costs in any way that I can to establish new and diverse forage crops and plants that will enable better health and faster finishing of livestock at maximum weight gain. This will in turn enable my business future sustainability throughout the uncertain times and aid profitability for my family and also the wider industry, to gain the security it needs for the next generations.

14.0 Acknowledgements

I would like to thank HCC for the opportunity to travel to both New Zealand and Ireland.

Also it would not have been a scholarship without all the families and business' that showed me hospitality, kindness, openness and honesty on my travels and for that I am grateful and am willing to return any favours welcoming them into my home and business in Wales.

Ultimately, though I would like to thank Rachel my wife and our three young sons, Harrison, Fraser and Caleb for their continued support through the

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