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Report

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Are Mob Grazed Cattle the Perfect Arable Break?

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Contents

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Executive Summary

The Great Grazing Herds

From "The Extermination of the American Bison" by William T Hornaday, reproduced by Project Gutenberg

The great herd on the Arkansas [River] through which I passed ……. was, from my own observation, not less than 25 miles wide, and from reports of hunters and others it was about five days in passing a given point, or not less than 50 miles deep. From the top of Pawnee Rock I could see from 6 to 10 miles in almost every direction. This whole vast space was covered with buffalo, looking at a distance like one compact mass, the visual angle not permitting the ground to be seen. I have seen such a sight a great number of times, but never on so large a scale.

The term 'mob grazing' means keeping large numbers of cattle on a small area of land and moving them frequently. The land then enjoys long periods of rest before the cattle return. It is mimicking how huge herds of wandering bison or wildebeest or caribou used to move through an area, trampling and grazing all around them before they departed, literally, for pastures new, leaving the grasses to grow, mature and reproduce once more.

Grass plants have evolved over millions of years under such grazing regimes and it is only during the past few hundred years that we have started using enclosures and fields, exposing the grasses to completely different grazing pressures, involving constant grazing and re-grazing of the immature plants. Grasses and other forage plants are poorly adapted to such treatments and consequently productivity is much reduced.

By emulating the huge herds of yesteryear, mob grazing encourages the grass plants to complete their full lifecycle, improving overall capture of sunlight and hence improving the land's productivity. Additionally, mob grazed cattle trample significant quantities of forage onto the soil surface, feeding the microorganisms and other soil life and increasing the soil organic matter.

A happy side-effect of allowing grasses to grow to maturity is that cattle are much healthier. They too have adapted to eat large amounts of bulky forage material with a good combination of fibre, protein and energy. The sheen on their coats and the firmness of their dung, coupled with the growth rates and overall health of their calves is testament to the benefits of mob grazing more mature pastures.

Incorporating cattle into an arable rotation offers real financial benefits. Soils become more fertile and, if the right mixture of forage is grown for grazing, significant savings in nitrogenous and other fertilisers can be made. The friability of soils also improves and both its water holding capacity (useful in a drought situation) and the rate of water infiltration (useful during periods of heavy rainfall) are greatly improved. The bottom line is that cattle in the rotation can improve your bottom line! Profitability is enhanced and the environment is much improved too.

Background

My interest in farming started when I was very young, steering a tractor round a hay meadow in North Staffordshire as my grandfather and uncle loaded hay bales onto the trailer. Despite not being the son of a farmer, I used to spend most of my holidays helping out various uncles, cousins and my grandfather on their different farms and, as I got older, I kept pigs, chickens, sheep and store cattle on a small area of land at home.

My appetite well and truly whetted, I obtained an honours degree in Agriculture & Land Management from the RAC and went into dairy herd management. After several years I became a farm business advisor with Grant Thornton and then progressed to become an agricultural banker with HSBC and Clydesdale Bank.

However, after ten years away from actually farming and with each step up the career ladder, I realised that I was getting further and further away from the heart of the industry I loved and so in 2007 I set up a consultancy and estate management business in Hertfordshire. I am lucky to have, as one of my core clients, a traditional country estate owned by the Bowes Lyon family. Not only do they have both arable and livestock enterprises but they have also been very supportive of my mob grazing trials as well as being keen to look at direct drilling and other soil improvement techniques.

I am also extremely lucky to have an incredibly loving and supportive family. My wife Helen somehow manages to hold down a job as a partner in a top city law firm as well as making sure we are all clean, fed and watered and covering for me when I'm away on my travels. In addition, she looks after our two wonderful children, Will and Imogen who, despite pretending to be bored by me talking about soil and mob grazing all the time, secretly love it!

So why did I want to study mob grazing? This desire has its roots in my early childhood. I grew up thinking all soils were like the ones I was raised on – rich, dark and friable, the product of centuries of livestock-covered permanent pastures. There were hardly any arable farms in this part of the world and so the only cultivated soils I saw were the well-manured vegetable patches in our own gardens.

It was only when I first visited East Anglia that I realised that soils weren't all the same. The underlying rocks and the composition of the soil itself all have a bearing on its qualities and appearance. However, as I learned more, I realised that there was one critical factor missing from many of the soils I saw on all-arable farms. That something was organic matter!

As I looked more closely at the subject, I realised that poor management could even result in grassland soils having a low organic matter content and, consequently, these soils would have poor fertility, be prone to compaction and flooding, would be droughty and lacking in soil life. There had to be a solution out there somewhere.

The answer came in the form of a blog, written by a Nuffield Scholar, about mob grazing practitioners he'd met during his travels in the US.

It was like a light bulb going on in my head. This was the answer! We could use cattle to improve the soils under our feet. The technique seemed complex to understand and yet simple to put into practice. All I needed to do was to learn more about it.

This is where the Nuffield Farming Scholarships Trust came in, aided and abetted by the John Oldacre Foundation. Through their incredible kindness and generosity, I have had the opportunity to travel the world, meeting some of the greatest practitioners of mob grazing and soil management along the way.

This report *(and my accompanying blog at www.mobgrazing.blogspot.com)* is a result of that study, and I hope you enjoy reading it as much as I enjoyed writing it.

Me - picture taken on a wet morning in Paraguay

Introduction

The basic premise of mob grazing is one of high stocking densities – huge numbers of cattle bunched into tight groups – which are moved frequently with the aid of electric fences, trampling into the soil as much forage as they graze. The pasture land is then left, untouched, until it is fully recovered, giving opportunities for a whole host of plant species, that would otherwise be grazed out or out-competed, to establish in the sward.

Mob grazing simulates the vast herds of bison that used to migrate across the American plains, or the millions of wildebeest that still sweep over the African savannah, or the famous European auroch herds that grazed their way across our own continent thousands of years ago. The grass plant evolved alongside such migrations, adapting and specialising to a life cycle that included short, intense periods of grazing and trampling followed by long rest periods. I realised that it is only in the last few hundred years that grasses have been managed differently and that such management is detrimental to the long term productivity of our grasslands.

1000 head of mob-grazed cattle in Canada enjoying a mature pasture.

To understand exactly why mob grazing works, it is important to break down the process into its component parts. Firstly, the long recovery time between grazings allows the plant to establish a healthy root system. The roots grow deeper into the soil, bringing up hidden nutrients and making the plant more drought-hardy. Carbohydrates are also stored in the root and provide the energy vital to feed the new regrowth post-grazing. The long recovery time also leads to high volumes of above-ground forage, a mixture of leaf, seed and stem.

The high stocking density means up to 50% of the plant is trampled to the ground by the animals. Cattle turned into a fully mature pasture graze the lush tops of the plants, eating seedheads and upper leaves full of energy and protein. The tougher, lower stems are

trodden onto the soil surface and these stalks act both as a mulch and as a food source for the soil microorganisms, building new soil in the process.

The cattle only eat the best parts of the plant before being moved onto a new area of ground, and this is why performance doesn't suffer – they are not forced to eat the poorer stems *et cetera* – and their dung is tight and firm, reflecting the balanced diet they are getting.

A freshly mob-grazed pasture – here in the UK – showing heavily-trampled forage

As the organic matter rises and the soil becomes more fertile, the land grows more forage and stocking rates – the total carrying capacity of the land – increase. Neil Dennis, a Canadian farmer, improved his stocking rate fourfold. As he pithily observed, he'd gained the equivalent of another three farms at no extra cost, and is now harvesting and selling sunlight (in the form of beef) much more efficiently than under a set-stocked regime.

Another notable feature of mob grazing is that the permanent pastures don't appear to become worn out. Conventional reseeding is unheard of, and both grasslands and their underlying soils are healthier than ever before. As practitioners regularly point out, it is farming in nature's image, mimicking what has happened naturally for millions of years.

There are many hurdles stopping cattle being part of an arable rotation in the UK, the most important one being the apparent lack of financial return compared to repeatedly growing combinable and root crops. Unfortunately, a lot of the benefits of having cattle on the land are only realised in the following crops and our gross margin system of budgeting takes little account of things like easier working, more friable soils, residual nitrogen and improved

water-holding capacity. My travels through Argentina demonstrated the financial value of these things, and my report highlights ways to quantify many of these hidden benefits.

Lack of skills and a lack of infrastructure – water, fencing, housing etc – are also genuine obstacles to using cattle within an arable rotation. However, one person's obstacle is another person's opportunity. One of the main conclusions I have reached following my study is that, if I and others can offer a cattle grazing service that provides financial rewards to the landowner equivalent to more conventional break crops, then there are tens of thousands of acres of arable land across the UK that could benefit from the actions of grazing livestock.

In my mind's eye, I see vast herds of ruminants mob-grazing their way across East Anglia, adding natural fertility to the hungry soils and making farming more sustainable. If I achieve this in my lifetime, I will know my Nuffield Scholarship has been a success.

Thank you again to all who have given me this opportunity.

The Mob-Grazed Grass Plant

Grasses have been on earth for a very long time. Archaeologists believe the earliest grass pollens date back some 65 million years. It is one of the most successful plant species on the globe, with grass plains covering much of the temperate regions of our planet. It provides a food source to millions of animals, both wild and domesticated, as well as forming the bulk of the human diet.

In the last five or six million years, the grass plant has evolved in conjunction with the great grazing herds of the plains and is perfectly adapted to periodic defoliation and subsequent rest periods. A key adaptation is the location of the growing point on a grass plant, which is found in the crown of the plant, at or just above the soil surface. This protects it from potential damage by large grazing animals and allows it to regrow quickly once the herds move on.

Another feature of the grass plant is the ability to store carbohydrates in its roots. As a plant is defoliated, it uses these root energy reserves to create new leaves (which grow from the protected growing point). These leaves in turn capture energy from the sun through photosynthesis which both replenishes the root reserves and is used for respiration and reproduction by the plant.

Three Leaf Grazing

From *www.mobgrazing.blogspot.com*

Popular convention in the UK and elsewhere says that grass should be grazed at the three-leaf stage. Beyond this, it either puts up a seedhead or, as it puts out a fourth leaf, the first one dies, so three is the magic number. Popular convention may be wrong!

Neil Dennis is a Saskatchewan farmer who runs cattle in mobs of 1,000 head. He packs them in tight and moves them every couple of hours. He's been mob grazing for a decade now and he says his land has changed out of all recognition.

One of the most noticeable changes has been to the growing patterns of his grass plant. As the mob grazing has improved the soil, the plants have been able to put down deeper roots. This has meant they are less drought prone in the 12-15" annual rainfall area that is south-eastern Saskatchewan. They also have a much longer recovery time between grazings so can develop fully.

Neil says the result is that they are no longer stressed, and a plant that isn't being stressed doesn't have to enter the reproductive phase, it can just carry on putting out new leaves. Not just any old leaves either. The claims Neil makes, that the leaves have got broader, longer and 'juicier' (a technical term, based on the high sugar content measured using a Brix refractometer!) really appears to hold water. Neil & I studied a grass plant, picked at random, from a field that had had 60 days' rest.

The first leaf had indeed died off, a shrivelled up brown thing near the base of the stem. However, the plant had subsequently gone on to grow 13 more leaves, ALL of which were still green and busy capturing sunlight!

13 leaves! For those who are poor at maths, that's ten more than under the conventional rotational grazing practiced in the UK. So each plant has four times as much leaf area as conventional grazed ground would see. Extrapolate this up and an acre of ground being mob grazed by Neil would have 4 times the amount of feed. Juicy feed. Excellent feed.

Three leaf grazing is dead. Long live 13 leaf grazing!

Different species of grass differ in the timing of their growth through the year, but all follow a broadly similar growing pattern. Upon awakening from winter dormancy, they start to produce new vegetative leaves and tillers from their growing points. These leaves are like mini solar panels, all helping to intercept the sunlight that streams down to earth, converting it into chemically stored energy. Growth during this phase is rapid.

Photosynthesis

From *www.mobgrazing.blogspot.com*

Carbon dioxide + water + energy = carbohydrate + oxygen + water

or

$6CO_2 + 12H_2O + \text{energy (sunlight)} = C_6H_{12}O_6 + 6O_2 + 6\ H_2O$

It's as simple as this. A plant takes carbon dioxide out of the atmosphere plus water out of the soil and converts them into a simple sugar (a carbohydrate) which is stored within the plant to be used either as a future energy source or the carbon is used to create the 'backbone' of the plant (starches, cellulose etc). Whilst locking up the carbon, the plant emits life-giving oxygen (plants are the source of all the oxygen in the atmosphere!)

Note also that the sun's light energy is converted into chemical energy in the process. Hence, all our fossil fuels and all our biofuels are simply sunlight energy that has been captured by plants and turned into chemical energy which is then 'stored' in the plant.

After a while, the plant has sufficient energy-capturing leaves to allow it to enter into its reproductive phase. At this point, it starts to grow reproductive tillers, bearing the familiar stem and seed heads. Vegetative growth slows down as the plant puts much of its energy into the reproductive phase. At the end of this phase, annual plants senesce and die, whereas perennial grass plants enter a brief stage of slow growth before a secondary vegetative growth stage begins at the back-end of the year.

Traditionally, livestock farmers graze plants during the vegetative stage, stopping the grass from throwing up reproductive stems and restarting the cycle.

However, many of the mob graziers I met believe grass plants become exhausted over time if they are not allowed occasionally to complete their natural life cycle – necessitating reseeding and other costly remedial work. They emphasised that a plant was only fully mature when it had completed its reproductive stage. This means that the recovery phase – the period when animals are kept away from the plant – can be anything up to 100 days or longer, depending on climate, rainfall, time of year, latitude etc.

Bunchgrass defoliated at four different heights shows how the roots mirror the above-ground foliage

They are not averse to grazing a plant before it reaches maturity but they believe firmly that

occasionally the grass plant has to be allowed to follow through all the phases of its lifecycle to remain healthy. As they regularly pointed out, grasses have evolved under a system of rapid and extreme defoliation followed by many months of uninterrupted growth and grow best under such systems.

An interesting result of allowing the plant to reach maturity is the vast quantities of forage that are produced per hectare. Some of the warm-season, or C_4 grasses I saw in North America stood higher than the cows, at over six feet tall and even here in the UK, stems of between four and five feet are achievable.

Equally interesting is the claim that underground roots mirror the above ground forage. The picture (pg 8) shows an experiment in the US where bunchgrasses were defoliated at different heights, demonstrating quite clearly this phenomenon. Allowing plants to mature fully results in the formation of large, complex and deep root systems. These are able to extract vital minerals from lower down in the soil strata, they are better able to reach water supplies during a drought and, when they die off, they leave huge amounts of valuable organic matter in the earth.

The huge amounts of above-ground forage also capture large quantities of sunlight. As farmers, it is important to remember that this is what we are

Capturing Sunlight

From *www.mobgrazing.blogspot.com* – This was a debate I had with George Brizuela-Kirk, a Paraguayan cattle rancher, about which field to graze next.

The dilemma was as follows: The first field available had previously run out of drinking water during the drought, consequently the cattle hardly grazed it before they moved on to a new pasture. Because it was hardly touched, this field had a good quantity of grass in there, and it was all still very leafy and growing well. It had been rested, by default, for longer than any other field on the ranch.

The alternative field had much less grass on it. The green area wasn't too high and as a consequence I suspect a lot of the available sunlight was not being captured and turned into dry matter. It was only growing slowly because it hadn't yet got the leaf area to allow it to speed up growth, it was still in the early stages of the regrowth cycle.

One other factor to bear in mind: George estimated that there was probably another month to go before the ranch's grasses entered their winter dormancy period.

Which field would you graze?

George's instinct was to put the cattle into the field with the most grass. This would keep them occupied for up to a fortnight, allowing the second field, with much less ground cover, time to regrow.

I argued that instead he should put the cattle into the second paddock, the one with less grass. My reasoning was that the first field, with the greatest green area, was much more efficient at converting sunlight into dry matter. To make a financial analogy, you could say it was like having £140,000 deposited in a bank account which paid interest at 20%. The second field, with lower grass cover, was the equivalent of having £70,000 deposited in a bank account earning 4% interest.

By leaving the field earning you the greatest amount of interest/dry matter, the total growth on the farm will be maximised, even if the cattle have to be kept on a tight ration for a short period.

in the business of doing. We are selling sunlight (in the form of meat, milk, grains etc) to the rest of the world. The more efficiently we can capture the sun's energy, (which freely streams down to earth every day) the more people we will feed and the more money we will make!

Allowing grass plants to mature can produce incredible amounts of forage. Here, Dr Allen Williams' suckler cows graze tall, mature pasture in Mississippi, USA. Three years ago, this land was covered in trees and scrub, having been in CRP (the US equivalent to long-term set-aside, but with no topping or brush-cutting!) Allen used a bulldozer to clear the trees, then did nothing else, other than mob-grazing the cattle. Allen's management had transformed the land from weed-covered scrub to dense, productive sward after only three years of mob-grazing. Incredibly, no reseeding had taken place, the clovers, grasses and other legumes were all either already in the seed bank (and had been dormant for the past 25 years+) or were carried/blown in from elsewhere.

The seed heads on a grass plant are also full of carbohydrate and hence concentrated bundles of energy – admittedly not as plump as cultivated wheat or barley grains, but nevertheless they are extremely nutritious. Mob grazed cows, turned in to a mature pasture, strip the seed heads off the plant with relish. It's like self-feeding grain to the cattle out in the field!

Finally, allowing grass plants to reach maturity and set seed means the pasture effectively renews itself each year. A significant number of the grass seeds will be shed onto the ground. Some will fail to germinate and will decompose (feeding the soil biota), some will be eaten before they reach the soil, but a significant number each year will land on the soil or on a cowpat and will germinate, constantly refreshing and reseeding the pasture, for free!

Soil Organic Matter and the Carbon: Nitrogen Ratio

The first thing to know is that different plant materials have different Carbon to Nitrogen (C:N) ratios. A leafy legume (say clover) may have a C:N ratio of 15:1. Wheat straw, on the other hand, may have a C:N ratio of 90:1

Now, to keep things simple, let's say the first bacterium that comes along to eat the organic material has a C:N ratio of 6:1 - its body has 6 atoms of carbon for every atom of nitrogen. The bacterium eats the clover plant which has a ratio of 15:1. 60% of the carbon consumed by the bacterium will be used as an energy source during the respiration process and will be lost as carbon dioxide. Conveniently, 60% is 9 of the 15 parts of carbon, leaving just 6 parts of carbon to 1 part of nitrogen (C:N = 6:1). This happens to be exactly the proportion of C:N needed by the bacterium to build its 'body', with the result that no N is absorbed or secreted.

This bacterium then dies and gets eaten by a larger organism. Higher up the food chain, the C:N ratio tends to increase, so this second organism may have a C:N ratio of 8:1. The second organism consumes 6 atoms of C for every one atom of N. However, this organism also needs to use 60% of this consumed carbon as an energy source as it respires. Hence, 3.6 of the 6 parts of C disappear into the atmosphere, leaving a C:N ratio of 2.4:1 to be 'built' into the second organism's body. As it only needs a ratio of 8:1, there is surplus N in its diet and this N is secreted into the soil to be used by the plants.

This second organism then gets eaten by a third, larger one, 60% of the C is lost, surplus N is secreted into the soil and the process continues. The end result is that adding a plant material such as clover or another leafy plant with low C:N ratios will quickly result in N becoming available to the plant. This is one of the reasons why cover crops work so well.

However, in many arable situations, the majority of the organic matter laid onto the soil surface will be straw. As I mentioned earlier, straw could have a C:N ratio of 90:1. OK, let's assume the same initial bacterium comes along and eats the straw. Its 'body' is made up of C & N in a ratio of 6:1. It consumes the straw and respires 60% of the carbon as an energy source. This uses up 54 atoms leaving 36 atoms for every atom of N - hence after respiration the 'straw' has a C:N ratio of 36:1.

However, to build its 'body', this organism needs the C & N to be balanced at 6:1 (or 36:6) and not 36:1, in other words it needs to find another 5 atoms of N to be able to use the straw. This N is taken from the soil reservoir, hence the extra straw actually uses up N and you have to add extra nitrogen to allow the straw to be broken down fully. Once that first bacterium has got the C:N ratio down to 6:1, then the chain occurs as before, a larger organism comes along and consumes the bacterium, resulting in surplus N becoming available for the plants etc

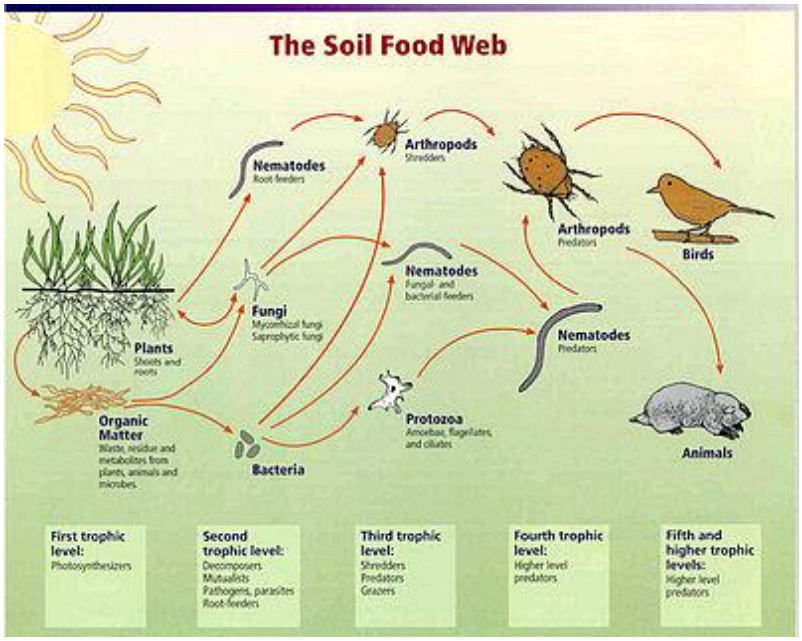
As the soil organic matter - plant and animal - increases, you reach a critical point: the N 'secreted' (as bacterium and higher life forms are eaten) is greater than the N required (to digest the straw or other high-carbon residues). This is the point at which you can start to reduce the N added, as the cycle starts to become self-sufficient.

Add into this mix nitrogen fixation from bacteria, both those on the roots of legumes and the free living bacteria, and you can see how nitrogen can build in the soil.

Just out of interest, one of the people I met in America - Gabe Brown - was finding that his soil was so active after 15+ years of direct drilling (and organic farming) with cattle included in the rotation, that even his high C:N ratio straw residues were breaking down within a few weeks. He was struggling to keep cover on his soil and was trying to grow ever more lignified crops to slow this process down! Incredible really!

Soil

The huge amounts of both above- and below-ground organic matter produced when a grass plant is allowed to reach full maturity is a valuable source of energy and nutrients for soil organisms. A healthy, living soil contains billions of bacteria, fungi, nematodes, arthropods and protozoa; I was told on various occasions that a tablespoonful of soil contains more bacteria than there are people on the planet.



The soil food web (Image courtesy of USDA NRCS)

There is a vast amount of life under our feet (another estimate I heard was that the below-ground animal life in an acre of healthy soil weighed the same as an adult cow). Consequently we, as farmers, need to give a lot more thought as to how these micro-organisms are fed. Once such life forms start to flourish, the whole food chain – including ourselves – will also thrive. The passage in the box on page 11, extracted from a piece I wrote on a farming forum, explains in simple terms the relationship between carbon and nitrogen as organic matter is broken down by the soil organisms.

Of equal importance are the end products of organic matter digestion. Humus is a catch-all term often used to describe much of the soil organic matter. In its truest sense, it is an incredibly stable carbon compound which has amazing properties. It has many negatively charged sites within its molecular structure and these negative charges 'hold on' to the positively charged plant nutrients (eg nitrogen, phosphorus, potassium and other important trace elements). It has huge water holding capacity, acting like a sponge and thus both allows heavy rainfall to penetrate the earth (rather than flowing away into streams and rivers) and then holds on to the moisture, making it available to be used by the plants during periods of low rainfall and drought.

Another, recently discovered, substance is glomalin. It is critically important to the formation of good soil structure, being a type of 'glue-like' substance which holds soil particles together in peds and clods. It is believed to be exuded by the mycorrhizal fungae which lives in a symbiotic relationship with healthy roots. Glomalin also makes us realise how little we know about the earth beneath our feet: despite the key role it plays, glomalin

was only discovered by soil scientists in the mid-1990s. How many more key 'players' in the make-up of our soils are still waiting to be found?

A South African 'Holistic Management Educator', Ian Mitchell Innes, told me an interesting fact about soils during my visit to Greg Judy's 'Mob Grazing School' in April 2011. Ian explained that the ratio of bacteria to fungi varied according to the land use. For example, heavily cultivated arable soils growing large amounts of annual monocultures will be predominantly bacteria-dominated. Conversely, undisturbed woodland soils with high levels of lignified material falling onto the soil surface will be populated by huge amounts of fungi and very few bacteria.

Permanent grassland sits somewhere in the middle, tending to have a balance of both bacteria and fungi in its soils. In a bacteria-dominated soil, annual weeds thrive. In a fungal soil, perennial woody shrubs do best. This allows us, as land managers, to study the weed species growing in our swards and fields to determine what is out of balance. In theory, if we get closer to the desirable ratios for grasslands, then desirable grass species will thrive and less desirable 'weed' species will not!

The Benefits of Organic Matter

Using mob grazing to build organic matter in your soils can have a dramatic effect both on the appearance and the productivity of your land. I have already referred to the capacity soil organic matter has for holding onto nutrients, making them more available for the growing plants. I have also mentioned the way organic

The Prairies: Part 2

From www.mobgrazing.blogspot.com

It was the sight of running water that made this visit one of the most inspiring of my trip.

I was visiting Phil Jerde, his wife Jill and their nine children on their ranch in South Dakota and was being driven round the western block of their land. Now, one of the benefits of managing grassland to increase soil organic matter is that the water cycle improves. As Jay Fuhrer so ably demonstrated with his infiltration test, soil with high organic matter has great structure and absorbs water like a sponge. Conversely water struggles to penetrate low organic matter soils and so runoff and evaporation losses are much, much higher.

Phil and family have been mob grazing their grasslands for a number of years now, grazing with a mixture of buffalo and cattle and giving adequate rest periods to the forage plants between grazings. Slowly, soil organic matter has been increasing. Rains are beginning to soak into the soil, being held in-situ rather than running off downhill. This water slowly seeps through the soil strata, being available to the plants for longer and gently weeping into draws (the natural valleys in the landscape).

Slowly, these draws are starting to green up. It begins with a small clump or two of warm-season (ie C4) grasses, often big bluestem or native switchgrass. Each year these clumps get larger until they start to meet and gradually the whole draw, or valley, becomes a verdant green oasis within the parched landscape.

It doesn't stop at this, though. The grasses gradually extend up the hill, as the soils improve, the water table rises and the bottom of the draw becomes damp, even in the middle of the day in 90 degree heat in August.

The ultimate sign that things are working properly is when you find, as we did, flowing water in the bottom of the draw. Getting the water flowing through the soil properly is vital whether you're in a low or high rainfall area. I am still agog at the incredible improvements Phil and his family have made to the landscape, just by managing the grazing properly.

matter improves the structure of the soil, 'glueing' particles together which not only improves water infiltration but also reduces soil erosion. In addition, this well-structured, high organic matter-containing soil has a much greater water holding capacity than soils with poor levels of organic matter – 1g of carbon can hold between 4g and 5g of water. This slows down the speed that rains pass through and over the soils, improving the water cycle and making more water available to the plant for longer during times of drought.

On Gabe Brown's farm in North Dakota, where he has been mob grazing and growing cocktail cover crops for over fifteen years (see page 43), I was handed a steel rod, some 1.2m long and with a small handle on top. Gabe asked me to try to push it into the ground. To my amazement, the rod slid into the ground like a knife into butter, all the way to the handle. Gabe explained that this was because his soils had excellent structure to great depths as a result of his focus on soil improvement and adoption of all available techniques to enhance his soils.

On Menoken Farms, also in North Dakota, Jay Fuhrer showed me the effect of combining mob grazing and cocktail cover crop mixtures to build organic matter, and the changes were equally dramatic. Grey sands were converted into a dark, rich, friable soil within just a few years (see page 43)

The greening of the land – high prairie on the Jerde ranch in S Dakota. As the water cycle improves, soil becomes more water-retentive. This, coupled with an adequate rest period allows native warm-season grasses to establish once again. The line between green and brownish vegetation can clearly be seen on the side of the draw (valley) and higher on the hilltops

Perhaps the most visually dramatic changes I saw, partly due to the scale of the change and the fact that it was a work in progress, was on Phil and Jill Jerde's ranch in South Dakota. As

mentioned in the box above (see page 13) the Jerde family farm a huge herd of buffalo, using holistically planned mob grazing to utilise the grass efficiently and improve the ranch soils. The results, in an otherwise dry and sparse high prairie, were nothing short of amazing. Vegetation was starting to appear in the natural draws, or valleys, in the landscape and more productive forage plants were starting to colonise this newly fertile soil.

The water cycle was starting to function again, with the infrequent rainfall no longer running off the land and being lost, but instead being absorbed and slowly seeping through the soil profile.

Big Bluestem grass in a draw on the Jerde ranch. There's a huge amount of forage here compared to the drier, shin-high material further up the hillside. What is exciting is the way the green area slowly spreads up the hill each year. I believe that one day, if Phil and his family carry on managing the land so well, the whole of his ground will be covered in dark green, tall, valuable forage

There were hundreds of draws and valleys on the Jerde ranch that were showing signs of being transformed. Those on lower land were much further advanced, with the green, lush forage starting to spread high up the sides of the draws. Draws much higher up were only just starting to show signs of improvement, with small, isolated patches of more productive grasses and other plants growing in the base of the draw.

The beauty of this is that as more grasses are produced, there is more organic matter available to be trampled into the soil. This further improves soil fertility and water holding capacity and so the rate of improvement increases still further.

The improvements were most clearly visible when standing alongside the boundary fence on the Jerde's ranch, comparing their grassland with that of their neighbours. As the following picture shows, the improvements were tangible and were all a result of improving the soil organic matter content.

The benefits of properly planned grazing. In the foreground is land on the Jerde Ranch, with lush green grass growing right up to the fenceline. On the far side of the fence is a neighbour's paddock, showing poor grass growth and drought stress due to overgrazing, a typical result of set-stocking the land and not giving plants sufficient rest. The whole of the ranch showed this level of improvement compared to the surrounding land.

Mob Grazing

Mob grazing is a generic term which means the grass is exposed to “short duration, high-density grazing followed by a long recovery period”. A naturalist by the name of Allan Savory is credited with being the first person to realise that properly managed cattle were good for the environment. Although I haven’t, yet, had the opportunity to meet him, I did meet one of his former business partners, Ian Mitchell Innes, who’s a ‘Certified Holistic Management Educator’, a body founded by Allan to promote his ideas.

Allan’s story is an interesting one and explains much of the thinking behind mob grazing. He grew up as a naturalist and game warden in Zimbabwe (formerly Rhodesia). Whilst carrying out his activities, he grew to believe cattle were the devil incarnate, causing massive erosion and desertification of vast tracts of his beloved lands.

Infuriated, he started to fence off large areas of the game reserves, banishing cattle and other forms of livestock, determined to heal the land. Instead, much to his shock, the land continued to deteriorate. This puzzled and frustrated him and forced him to look at the problem much more deeply.

Fortunately, Allan is an extremely observant and intelligent person. He noticed how grasslands on the

Farming in Nature's Image

From *www.mobgrazing.blogspot.com*

'Farming in Nature's Image' is a simple and very successful concept. It means working with nature, making decisions based on what would happen in the natural world if Man wasn't interfering.

Mob grazing is one example - I've already talked about the massive herds of grazing animals that used to roam the grasslands of Europe, Asia and America and which mob grazing, albeit on a small scale, tries to emulate.

The growing of cover crops is another example. Nature hates bare soil. She will do her utmost to cover it, firstly with fast growing weeds, forbs and brassicas, then with legumes and grasses and finally, if the climate is favourable, with bushes and trees. Nature also hates monocultures. They are never seen in the natural world. Instead, different species fill different micro-niches in the same area, the result being a mixture of small and tall, leafy and woody plants all occupying the same area of land.

Planting cover crops is an attempt to mimic this, and as Gabe [Brown] and Jay [Fuhrer] both emphasised [during my visit to N Dakota], the more variety the better. Within their cover-crop seed blends, they aim for a mixture of warm season broadleaves, warm season grasses, cool season broadleaves and cool season grasses, to ensure growth at different times of the year and under many different weather conditions. The ratios of each will depend on the crops grown previously, the crops to be grown afterwards, and the current levels of biological activity in the soil.

Ideally, cover crops are 'harvested' by mob-grazed animals (again, it's believed that the more variety - cows, sheep, hens, deer, etc - the better). A proportion of the cover crop will be trampled, forming the vital litter covering on the soil. The remainder of the cover crop will be consumed, digested and excreted as dung and urine, mixed with high numbers of microorganisms from the gut - the latter is the vital additional biology the soil needs to spring into life.

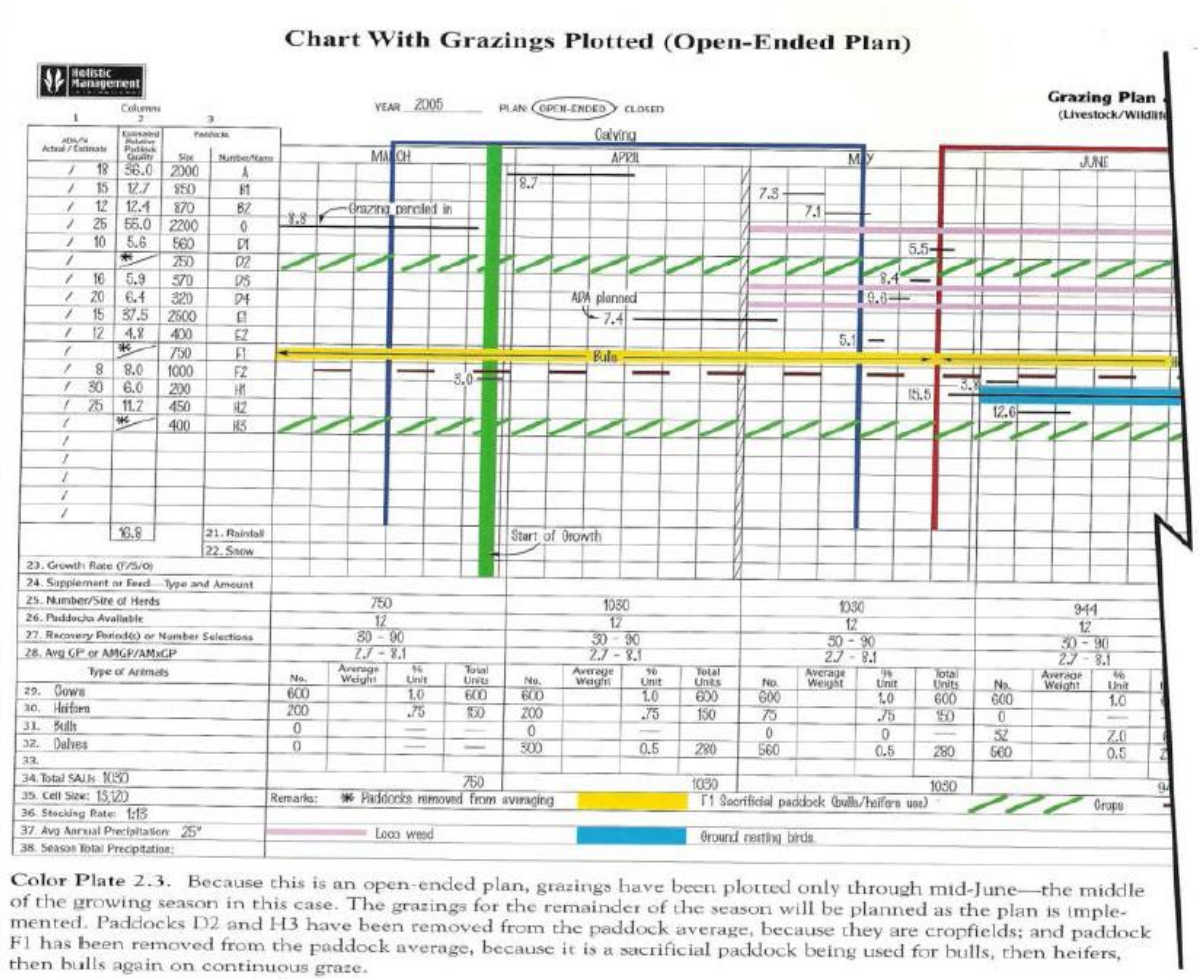
The principles of 'farming in nature's image' are simple: Look at what happens in a natural environment and use this to guide management decisions. Don't fight nature, it's so complex and has so many options, it will always win in the end. Instead, the message was clear, work with nature and you will reap dividends.

African plains were exposed to periods of intense defoliation and trampling as millions of wildebeest and other large grazing animals swept through on their annual migration and yet still grew back as thick and strong as ever. He realised that the critical factor was not the intensity of grazing but instead was the length of time the plant was exposed to repeated regrazing.

In conjunction with his observations, he also read Andre Voisin's seminal work, *'Grass Productivity'* in which the nature of grass growth and regrowth was explained in great detail. From these two sources he developed his 'planned grazing' approach.

Planned Grazing

Planning where and for how long the cattle graze is the critical first step to becoming a successful mob grazier. As with all plans, influences outside our control, such as rainfall, temperature, disease etc, mean things change through the seasons, but the initial plan



Color Plate 2.3. Because this is an open-ended plan, grazings have been plotted only through mid-June—the middle of the growing season in this case. The grazings for the remainder of the season will be planned as the plan is implemented. Paddocks D2 and H3 have been removed from the paddock average, because they are cropfields; and paddock F1 has been removed from the paddock average, because it is a sacrificial paddock being used for bulls, then heifers, then bulls again on continuous graze.

Grazing Planning Control Chart (Source: Holistic Management International / Kirk Gadzia)

provides a skeleton around which to base cattle movements. The illustration above gives an example of a planning chart commonly used by mob graziers.

Such a chart takes into consideration all manner of conventional things, such as calving and service periods and grass growth, but also some less conventional things such as staff

holidays, ground nesting birds and flooding risk, which also dictate which fields to graze and which to leave alone at certain times of the year. It is also important to assess the productivity of each field, in other words the expected amount of dry matter of forage it will produce in a typical growing season. A useful, and simple, calculation is to work out the "animal days per acre" (ADA) – take the number of animals on a given area of land multiplied by the days they remain on there and divide the figure by the area in acres (or hectares if you prefer to work out the animal days per hectare (ADH).

Holistic Management

Mob grazing is a part of the wider 'holistic management' principles. A key tenet of this is that every business decision should add to three separate 'bottom lines' to meet your goals.

The first one is the conventional 'economic' bottom line – we all want to make a financial profit!

The second one is an environmental bottom line: are we enhancing our environment to the best of our ability with our existing farming practices. As explained above, mob-grazing can be incredibly beneficial to the whole food cycle and wider environment.

The third and final 'bottom line' to consider is the social impact of our actions – on ourselves, our families, our employees, the wider community etc. Farming, especially livestock farming, is usually (and often correctly) viewed as being hard work with long hours and little time off. Managing cattle by mob grazing them – as I explain at length later in my report – attempts to tackle this issue, improving family life and providing more time away from the farm.

For example, keeping 100 cows on a 2 acre block for one day would give a forage yield of 50ADA. If that same area of land managed to feed 200 cows for one day, then the forage yield would be 100ADA, ie twice as much. If the higher number of cows come back to that same area three times during the year, then the total forage production by that field in that year will be 300ADA, giving a stocking rate of 0.82LU/acre – in other words, you would need 1.2 acres of that particular field to sustain one animal for 365 days of the year.

Obviously, early in the growing season, the ADA figure will be lower, as the grass has had a shorter growing season. However, you may be able to return for an extra grazing compared to the later-grazed fields, so overall productivity may not be affected too much.

Stocking Rate –v– Stocking Density

Mob graziers regularly talk about 'stocking density', sometimes in terms of animal units per hectare but often in kilograms of flesh per hectare (or pounds per acre, if you're speaking to a North American!). This is **not** the same as stocking rate. The stocking density is the number (or weight) of animals on a given area at any one time. For example, Chad Peterson in Nebraska would be stocking at densities of nearly 1,000,000lbs per acre, moving them onto a new piece of land every few hours to ensure they had enough fresh forage in front of them.

Meanwhile stocking *rate* means the number of animals on the holding through the year, a standard figure used on all UK livestock farms.

The reason stocking density is important to a mob grazier is to do with the trampling effect we are looking for: The higher the stock density, the higher the amount of forage that gets trampled. As a consequence there is less forage available to be consumed by the cattle and so they have to be moved more frequently. To 'conventional' livestock farmers, this trampled grass is wasted grass.

One of the main criticisms raised by people studying the system for the first time is that too little grass actually gets eaten! A significant proportion – up to 50% – is trampled onto the soil surface. This hard-won grass isn't doing its job, they will say, and the beasts will never fatten unless it consumes the grass. Of course, the answer is that we are feeding the soil microbes, nematodes, arthropods, fungi and a host of other beneficial organisms that lurk in the soil, craving nutrients and, in return, creating new soil.

The Social Bottom Line

Blain Hjertaas is a Saskatchewan beef farmer who practices holistic farm management and indeed is a certified educator with the organisation. He used to be an arable farmer but realised he was doing more harm than good to the environment in his low rainfall area so, applying holistic management principles, decided to farm livestock to heal the land.

As well as meeting his environmental bottom line, Blain also wanted quality of life to feature in his decision. Consequently, he chooses to only move his cattle twice a day in summer and once every three days in winter (all cattle are kept outside throughout the year).

This means there is little work needed to look after the animals, with occasional electric fences to be moved and re-erected being the main chore. This frees up a lot of time not normally available to keepers of cattle and allows Blain and his family to enjoy a more rounded, fruitful and rewarding life.

The higher the stocking density, the more quickly such beneficial organisms can grow and multiply and the more quickly new soil is formed. Neil Dennis, another Saskatchewan mob grazier, believes there is no other farming system on the planet which creates new soil like mob grazing. This is one of the most exciting factors to come out of my study. Instead of slowly losing topsoil, we can rebuild it, restoring fertility, reducing erosion and healing the land. We need to increase the numbers of cattle on our land and they need to be stocked at high densities!

The trampled forage also protects the soil from the vagaries of the weather. The litter insulates the ground from temperature swings which creates a more beneficial environment for the bacteria and other creatures to work in. Neil Dennis has measured the soil temperature during the heat of the midday sun and has found the protected soil is some 15^{o}C lower than adjoining bare patches of soil lacking vegetative cover. It also slows down water evaporation, maintaining a dark, moist environment for longer – again providing an ideal climate for bacteria, earthworms and the like to digest and break down the flattened grasses.

The Impact of Mob Grazing

From *www.mobgrazing.blogspot.com*

Mob grazing is about repairing the soil. Large amounts of litter (ie plant material, not plastic bags and old newspapers) is laid down on the surface of the soil by the grazing animals as they pass through, replicating what the large grazing herds of Europe and North America did over tens of thousands of years (until man wiped them out). In fact, grassland has evolved under such conditions, namely a short period of intense grazing and trampling as the herds passed by, followed by a long rest period for regrowth.

So, large amounts of litter are laid down on the soil. Blain Hjertaas called this the 'armour' - it protects the soil from damage by rainfall, from extremes of heat and cold, from sunlight, from hoof damage. Greg Judy called it a mattress. I'd call it a mulch. I forgot to ask Neil [Dennis] what he called it, but you get the picture!

One of the secrets to good mob grazing is to give the plants enough recovery time. There is no magic formula for this. Location, altitude, latitude, rainfall, temperature, cloud cover, management, etc all impact on this. Neil used to be on 90 days recovery, though as his land has improved, he's seen that come back to 60 days. Blain favours 100 days to allow all his plants to recover.

Neither of them are too concerned about seed heads either. In fact, they like to see them, for two reasons: One is that it shows the plants are fully recovered from the previous round of grazing/trampling and will have replenished their root carbohydrate stores fully. This will allow speedy regrowth post-grazing. The second reason is that seed heads are a valuable source of carbohydrate. They balance the protein lower down in the leaf and lead to excellent animal growth rates. A sign that the protein:energy balance was right in both Neil's and Blain's animals was that their dung was tight and well formed, not sloppy and loose (a sign of too much protein, and typical of the dung of conventionally grazed cattle).

Grazing area

Returning to the theme of planning the grazing, the first potential stumbling block is estimating how much land your herd of cows will need each day. A simple rule of thumb is that a lactating or growing animal will need a daily dry matter allowance of approximately 3% of its liveweight. So, a 500kg cow will need to eat 15kg of dry matter which is the equivalent of c.80kg of fresh grass. Grass covers under a typical mob-grazing regime can vary from 4,000kg/ha DM early in the grazing season to over 6,000kg DM/ha later on in the year. Taking the former figure, 1 hectare would, in theory, provide enough grazing for 160 cows for one day (assuming there was 1,600kg DM left behind at the end, as soil litter).

If you decided that you wanted to increase the trample effect, you could increase the stocking density and look to trample and leave behind 2,000kg DM of forage at the end. This would mean your 160 cows would eat 2,400kg DM in total and to do this would require 0.6 hectares of land twice a day (ie 1.2 hectares in total). By giving them two smaller pieces of land, we are intensifying the trample effect, with the extra land area compensating for the additional trampled forage.

Grouping Mob-Grazed Cattle

As I have already discussed, critical to the success of mob grazing is gathering the cattle into as few groups as possible. As a very simple example, imagine you, as a farmer, have your

farm divided into four large paddocks and you keep two herds of 50 cows (100 cows in total). Half the farm is being grazed by the two herds at any one time and you 'swap' the cows over to the other half every twenty five days, once the grass has recovered – a not untypical, low-input system.

This is a mob-grazed field approximately ten days to two weeks after grazing. Neil Dennis was in the middle of a drought, so the alfalfa was the first to regrow. Note how deep the litter or 'armour' (or 'mattress' or ...) is!

This means that, for 25 days at a time, half of the farm is being overgrazed – as plants try to regrow they are repeatedly bitten off, draining their root reserves and weakening the plant. Forage productivity would be poor, soil organic matter would be low and the cattle weight gain would be significantly restricted. It would also mean that, through a 200-day grazing period each grass plant is exposed to a grazing animal for 100 days.

By contrast, a mob grazier would gather all the cows into one group and would give them one-fiftieth of the farm, as a group, each day. The overall stocking rate would remain the same as would the time period – 50 days – that would lapse before they started again in the first paddock.

The difference, however, would be that each paddock now gets 49 days' rest before being exposed to a grazing animal again and, equally importantly, it would only be exposed to a grazing animal for 4 days in total during the 200-day grazing period, as opposed to 100 days under the first example!

The impact of this on grass growth, on root structure, on sunlight interception and on carbon capture, to name but four, is huge and demonstrates quite clearly how mob grazing can be beneficial.

Extended Grazing

I met dozens of livestock farmers on my travels through Canada, the US, Argentina and Paraguay and none of them kept their cattle indoors. Climates varied from 15" of rainfall with short, hot, dry summers and long, cold winters in Saskatchewan to 50"+ rainfall and humid summers in Missouri. The farms on the coastal Pampas of Argentina had a temperate climate with 32" of rainfall and a few winter frosts whilst the area of Paraguay I visited was

subtropical with an average of 60”+ of annual rainfall. Despite the wide variation, all farmers managed to keep their livestock on the land throughout the year.

Contrary to what you may think, and despite the animals being held in large, high density groups, the mob-grazing of cattle really helps to extend the grazing season into autumn and winter. There are various reasons why this is the case.

The first is that as organic matter in the soil increases, the risk of compaction decreases. As an extreme example of what I mean, think of walking on pure peat: Even if it was saturated, it still wouldn’t compact and would spring back into place. Obviously, ‘normal’ soils will never become pure peat but they will, in a relatively short space of time, accumulate a layer of ‘peaty’ organic matter on their surface.

The second reason is that the cattle are entering paddocks with very high quantities of forage. This means their feet don’t even reach the soil, instead being ‘supported’ by the forage. In very wet times, on a heavy clay soil, the forage may be pushed onto and into the surface of the soil, but poaching or puddling never happens, or should never be allowed to happen!

Bale Feeding and Out-wintering Cattle

From *www.mobgrazing.blogspot.com*

I was shown something counter-intuitive on Blain Hjertaas's farm. He outwinters his cattle, setting out large round hay bales in rows across the chosen fields during the preceding autumn. During the winter, electric polywire restricts the animals' access to the bales, being moved every two or three days to allow them to get to new bales. In effect the cattle are kept in a mob to consume the bales as well as the grass (which Blain has left ungrazed in that field for some months previously).

Now, I would expect that having large numbers of cattle on the land in winter would damage the sward. Also, the cattle never eat the entire bale so I assumed the remaining large quantities of litter would prevent grass regrowing in these areas.

I was wrong on both counts. We inspected the field used by the cattle the previous winter and the effect was nothing short of amazing. Where the bales had lain, the grass was a rich green verdant colour, lush and sweet. Admittedly, in patches, matted hay still lay, rotting down. Blain said this would be gone by next year and in any case, he explained, it had been proven that the extra grass growth round these patches more than compensated for them.

Mob grazing in the spring and summer following also helps to remove the patches, as the hooves break up the residual hay, allowing grasses and other seeds to regrow.

The reason for the lush grass? A combination of additional fertility from the (bought in) bales, plus the extra carbon material laid down on the soil which was being converted into humus and thus aiding water retention and building organic matter.

Carbon in the soil. It should be every farmer's goal.

During wet spells, and especially during the winter, mob graziers reduce their stocking densities and move their herd before puddling occurs. They will also only lightly graze the forage mass before moving them on. This is very important: as cattle enter a new field, they will, first of all, eat the tastiest, most nutritious parts of the plant. Heads down, they move slowly across the paddock, eating as they go. Once the best parts have all been consumed, the cattle start to hunt around for food, and their movements increase. This increases

poaching risk. Leave them for too long in this state and they will start to damage both the soil and the crowns or growing points of the grass plant.

It is far better to move them on quite quickly, even if you leave a significant amount of forage behind. During the ensuing weeks, that forage will be rained on and will freshen up; it may even grow a little, if the winter temperatures are clement. When the cattle return to the field to take a second 'skimming' of grass, they will be much more contented and movements (and therefore poaching) will be reduced.

New season grass growth on Greg Judy's Ranch in Missouri. This area of ground had been covered in large amounts of stockpiled forage which had been grazed off during the winter. The two patches of brown are places where the litter can be seen lying on the soil surface. As well as seething with worms, these areas were also covered with hundreds of new seedlings, predominantly clovers.

Mob grazing also allows you to leave a 'standing hay crop'. Traditionally in the UK, this was called 'foggage', and was practiced extensively. Instead of cutting the grass for silage or hay, you should plan your grazing to maximise the amount of standing forage by the end of the growing season. Then, during the winter months, this standing forage can be mob-grazed, remembering to apply the points above, as an alternative to feeding hay or silage.

This is another reason why, traditionally, out-wintering cattle in the UK has failed in recent years. It is normal practice, after the silage has been made, to feed it using ring feeders located in one spot near to a gateway. The result is predictable: Cattle churn the surrounding land into a quagmire, tractors running in and out of the gateway on a regular basis create deep ruts and the whole exercise is doomed to fail.

Of course, it is not often possible to keep for the whole winter sufficient forage in the form of a standing hay crop and it is always prudent to have some bales of hay, silage or straw

available as an emergency feed source. These bales can be laid out across one or two winter grazing paddocks and eaten in stages using electric fencing (see page 23). This avoids the concentration of cattle in any one spot, as you get with ring feeders and troughs and hence minimises poaching and sward damage.

Labour, Fencing and Water

It is a fallacy that mob grazing is a very labour intensive way to keep cattle although it is understandable why people jump to that conclusion. The constant moving of cattle onto new pastures, the dismantling and re-erecting of electric fences, and the provision of water all takes time that a set-stocked, conventional farmer wouldn't need to worry about. However, having sat on both sides of the fence, so to speak, set stocking isn't the easy option it is portrayed to be.

Neil Dennis winding up his electric fence using a cordless drill! You can also see the yellow frame on the Kubota to hold the reel and fencing stakes within reach of the driver, to avoid having to dismount. The red rod at the front of the machine allows Neil to drive over electric fence wires (both temporary and semi-permanent) meaning he doesn't even have to open gates when moving round the farm!

For example, we used to have four or five different groups of cattle spread around the farm. It would take an hour or more each day just to drive round and check the animals. They would always be spread out across the fields they were in, and invariably at the far side of the land! With mob grazed cattle, the entire herd is in one spot. Typically, it takes longer to walk to the group than to let them through into the next block of grazing and as they are walking past you, it is a simple job to inspect each animal carefully to ensure it is healthy (invariably, any poorly animals will be last through to the new block).

Putting up new electric fence runs is probably the most time-consuming activity, though I tend to put up three or four days' worth in one go. This takes a couple of hours and so, for a morning's work, a whole week's worth of paddocks can be erected. Alternatively, if you're as ingenious as Neil Dennis in Saskatchewan, you could simplify even this process.

Neil has adapted his Kubota to make fence erection even easier. He has fitted a frame onto the front of the machine which holds his metal fencing stakes. He also has an attachment on one side to hold his wire reel. Neil hooks the wire onto a semi-permanent electric fence at one side of the paddock then drives across to the other side, unreeling the reel. Temporarily dismounting, he tightens the wire, then drives back along the line, treading in his fence posts as he drives, without leaving the seat of the Kubota! Back at the start, he connects the fence to the live wire and the job is done. Simple!

One other addition to the Kubota is a portable GPS unit. This tells Neil the area of land he is fencing off, thus enabling him to work out

Factory Farming

From *www.mobgrazing.blogspot.com*

I have a question for cattle farmers: What do you sell?

The chances are, your immediate answer would be something along the lines of *"Store cattle!"* or *"Beef!"* or *"Fat cattle!"* Wrong. Try again.....

Hmmm, how about *"Grass?"* Getting closer.....

Give up? The answer is sunlight! You are capturing light energy and converting it into a saleable form. It is as simple as that. You are virtually unique in this (maybe solar or hydro-electricity are almost there, though they always require some manufactured products before they can function).

Think about this for a minute. Sunlight is streaming down to earth. Every day, light radiation hits our farms. The more of this we can capture and convert into meat (or milk, or eggs or grains of wheat), and the less it costs us to capture it, the richer we become. It's a beautiful thought.

So how do we capture it efficiently? The answer lies in factory farming. In particular I am talking, in the case of a cattle farmer, about three separate but linked factories.

The first factory is the grass plant. This miracle of natural engineering has the ability to intercept the light shining down on to us. The more leaf area you have, up to a limit, the more sunlight gets converted into chemical energy. Chemical energy can be stored, used, sold. That is money!

The second factory is the soil. Grass needs nutrients from the soil. A living soil will be rich in all the nutrients needed by the plant. But, just like us, the living soil needs energy to stay alive. Where does that energy come from? Where else but the sun. We need to take some of the chemical energy now stored in the grass plants and give it to the living soil - the microorganisms, arthropods, nematodes, mycorrhizal fungae etc. So a significant part of the grass plant needs to be fed to the soil to keep it alive and healthy.

The third factory is the ruminant animal. The correct type of grazing animal has the ability to consume the grass and extract the energy from the grass, along with all the other nutrients that the grass plant extracted from the living soil. She will also, with her trampling, dung and urine, feed the living soil. This is a key point, part of the jigsaw puzzle that has been missing from many farms since the perfection of the Haber - Bosch process gave us artificial nitrogen.

stocking density and thus to assess how long the cattle can stay on an area of land before they need moving to fresh grazing.

As discussed above, mob grazing can also significantly extend the grazing season. The impact of this on the workload must not be overlooked. For example, conventional farmers typically spend huge chunks of their summertime making silage or hay to feed the cattle. They would spend weeks baling, carting and storing straw for winter bedding. Through the winter, hours every day would be spent feeding the housed cattle. Several times a week the cattle would need to be bedded up, and intermittently through the housing period and definitely at the end of the winter period, the yards would need to be cleaned out and the manure stored or spread.

By comparison, the mob graziers I saw around the world were simply spending their days moving an occasional electric fence and making sure their animals were given enough grazing for that day. The cattle gather their own feed and spread their own manure. Neil Dennis tells how, when he first started mob grazing, and despite moving his cattle several times a day, he found he had next to nothing to do in between times. He used to sit in the house drinking coffee and talking to his wife, but if his neighbour came round, he'd dart out of the back door and pretend to be busy digging his back garden! (He says he's got over this now, and just invites his neighbours in for a coffee!)

The provision of water is another aspect that gets conventional farmers scratching their heads as they often have just one water trough in the corner of a large, set-stocked field. How can cattle reach the water trough if they are sectioned off into a small area of the field?

There are various answers to this question. The first is to utilise the natural regrowth habits of grass and to remember how a plant becomes overgrazed. During the growing season a grass plant, once bitten off by an animal, doesn't start to put up new shoots for between three and five days. This means that even if the animal still has access to a grazed area during this time, it won't be given the opportunity to overgraze the grass plants because these plants won't have regrown. Therefore, any back fence you put up need only be keeping the animals away from grass that was eaten six or more days ago. In other words, the cattle can wander back to a water trough situated on previously grazed ground for up to five days after they've moved past it.

The second trick is to create a passage, using electric fencing, so that the cattle can reach water troughs in front or further behind them without going across ungrazed or recovering grass. This is a little more time consuming but the rewards are tangible in extra grass regrowth and better overall productivity. The third solution is to use mobile watering systems. Bowsers work well, although again they require extra labour to move and refill them.

This is a picture of Chad Peterson's mobile watering system on his ranch in Nebraska (borrowed from this website - http://handnhandlivestocksolutions.com/blog/?p=62 - as for some reason the photos I took failed to save onto my camera). Water is continually pumped from the ground into the trough using artesian pressure, with surplus water emptying through a sumphole and down a pipe onto the previously grazed field behind the cattle, soaking down through the sand land into the groundwater below.

The most obvious and long-term solution (though also probably the most capital-intensive), is to install extra troughs. Strategically placed, so that cattle can reach them from both sides of a semi-permanent fence and at sufficient intervals down the field will help to minimise the number required whilst at the same time keeping the overall grazing system simple.

Cattle Breed and Animal Performance

Choosing the right animal is one of the keys to the success of mob grazing. To understand which breeds are best suited, it is a good idea to recap what we want the animal to be able to achieve in a perfect scenario:

- All year round grazing with only small amounts of supplementary forage needed during the worst of the winter weather
- Able to live on forage alone with no concentrates or other expensive dietary additions
- Low “maintenance” feed requirement
- Lightweight animal to minimise soil damage
- Heavier weight offspring that can mature off grass-only diet
- A hardy animal, able to withstand the vagaries of the British weather
- Docility
- Easy calving
- Good longevity

Above all, the thrust of mob grazing is that it is a very low input system which achieves high outputs (measured in kilogrammes of beef produced per person employed) by enabling one person to look after large numbers of cattle. The end result is a highly profitable system

Which Breed?

The above list of requirements points determinedly towards the UK native breeds and this is indeed what I found during my travels. In Argentina, the majority of cattle were either Angus or Hereford. In North America, the story was the same. The exceptions were Paraguay where, being sub-tropical, the cattle mostly had *bos indicus* blood in them (though often crossed with UK native breeds to produce sub-breeds such as the Brangus, a mix of Brahmin and Angus bloodlines); also, in the US, Greg Judy was using a composite breed known as the

Mob grazing, naturally….

From www.mobgrazing.blogspot.com

It was last Sunday and I'd 'awarded' myself a day off to go and look at Mount Rushmore and its carvings. On the map, it didn't look too far (it turned out to be a 430 mile, 8 hour round trip, but that's another story!)

Two hours into the trip, I got very excited because on the distant prairie I spotted some dark shapes, tightly bunched together within the vast plains. It could only mean one thing: someone was mob-grazing cattle.

As I got closer, things began to look a little odd. I couldn't see fences containing the animals. Also, the dark shapes I'd assumed to be Black Angus cattle were taking on a strange shape as I got closer. Then it dawned on me. These weren't cattle at all. And they weren't penned in by electric fence. These were buffalo (bison), naturally forming into a mob as protection from predators and slowly wandering across the prairie.

For someone whose interest in mob grazing is almost becoming an obsession, it was a marvellous moment!

South Poll which included Africander and Zebu genetics as well as a significant proportion of Hereford, Angus, Red Poll and Shorthorn blood.

The other 'native' breed I saw in the US was the American buffalo or bison. Chad Peterson in Nebraska used to breed them before switching to Highland cattle; the amazing Jerde Family in South Dakota still have a huge herd of buffalo, as well as a small number of grass-fed Herefords. Obviously, there is nothing more suited to the environment of the American plains than the buffalo and that, really, is the whole point behind breed selection. Pick what is best suited to the area and ruthlessly select for those animals that thrive under your favoured style of management.

Bison, running alongside the highway fenceline in the Dakotas, a naturally formed mob

Breed and Calving Age

The calving age of the heifer is often cited as an important factor in overall suckler herd profitability. EBLEX has published research showing that calving at two years old, rather than three, helps to improve overall longevity and calves per lifetime of the animal, it reduces rearing costs and helps drive improvements in the bottom line.

From a mob grazing point of view, there is another, equally important, benefit. A heifer calved at two years old will be slightly but significantly smaller than an animal calved at three years old. The act of providing nutrition to the growing calf during pregnancy and early lactation keeps the animal at the small end of its genetic potential – in much the same way as humans were much smaller several hundred years ago, before they had access to our high calorie, carbohydrate-rich western diet.

The amount of dry matter an animal requires for 'maintenance' purposes (ie to keep its basic bodily processes functioning correctly) is directly correlated to its weight – a dry (non-lactating) cow will need to consume just over 2% of its own body weight in forage dry matter each day. Therefore, a large, continental-bred 750kg cow will need to eat 15kg of dry matter just to stay alive. A smaller, native-bred cow weighing 450kg (with size partly dictated by breed and partly by its calving age) will only require 9kg of dry matter for its 'maintenance' needs. In other words, you could keep five smaller cows on the same area of land as you could keep three larger cows. That's five calves to sell instead of three!

Another benefit of the smaller animal is the reduced risk of poaching of the soil. I have already discussed how the rising organic matter in the soil and the high volumes of above-ground forage helps to alleviate the damage to the soil. However, lighter animals will, by definition, put less pressure on the ground, leading to much less puddling.

What calving at two rather than three years old does not eliminate is the genetic potential of the animal. Its offspring still carry maternal genes which will allow it, given the right nutrition, to reach a satisfactory finished weight. The use of suitable, easy fleshing and shapely bulls will further improve the calf's likelihood of growing into a good, marketable beast. There really don't appear to be any benefits to calving your heifers beyond two years old.

The Grazing Cow

The farmers I met all had a similar type of cow in mind when they talked about their ideal grazing cow. Capacity was the most obvious: She needs to have a lot of depth to her chest with an excellent rumen volume, to enable her to eat the huge amounts of forage needed to maintain condition.

Coupled to capacity was a preference for short legs! Several farmers liked their cows to be close to the ground, and would look disdainfully at an animal that stood tall.

A broad muzzle is also desirable and the line of her cheeks should be parallel to each other with the muzzle nearly as wide as the eyes. A long, thin, triangular face indicated a poor forager whilst a short, squat, broad head meant the animal was likely to be a good grazing animal.

As mentioned above, all of the graziers I met favoured the smaller animal, with low maintenance requirements. Generally, they also liked a finer-boned animal, again saying its feed requirements were lower and it produced an animal with a better killing-out percentage – it would convert its feed to meat, not bone.

Although the white headed Hereford was common in most of the countries I visited, many of the farmers believed their white faces attract flies and consequently the Hereford suffers from a higher incidence of pinkeye (New Forest disease) than do other breeds. (As an aside, I know a couple of tractor drivers who, as they drive New Holland tractors, are always

wearing New Holland overalls. In case you're not familiar with these overalls, they are blue with bright yellow shoulders. The guys love them – except for during the summer time when they're working outside, as their yellow-coloured shoulders attract all the flies and insects in the vicinity! It's quite amusing to see them surrounded by annoying insects whilst alongside them, the plainly-dressed worker will be almost fly-free! So, although I digress, there may be some truth in the 'white face attracts flies' theory.)

A Healthier Diet

Farming in Nature's Image means trying to emulate what would happen if man didn't interfere with the natural functioning of the animal and plant kingdoms. I have already emphasised that mob graziers try to allow grasses to follow their evolutionary life cycle of hard grazing followed by long recovery periods and have explained how such practices benefit both the plants and the soil enormously.

However, we are all farming to make money, however altruistic we feel and so the health, wellbeing and overall performance of the ruminant animal are critically important.

One of the main issues people have with mob grazing is that the nutritive quality of the forages decreases sharply as the plant matures. As explained earlier, whilst this is true if you analyse the whole of the grass plant, for a grazing ruminant which can select the best parts, whole plant analysis becomes less relevant. There are several things to look for which give clues that the animal is being properly fed.

The first, and most obvious, are the normal indicators – coat sheen, weight gain, reproductive ability and general health. These are all things a good stockman would look for when considering whether his or her animals are being provided for successfully.

Less often considered is the dung. A ruminant's dung is a great indicator of the quality of its diet and yet, as soon as people put their animals out to grass, they ignore the warning signs that the change in the dung is

Breathless cows

From www.mobgrazing.blogspot.com

A panting cow may be a sign that not all is well within. Whilst I was at Greg Judy's mob grazing school, nutritionist Mark Bader explained the role of nitrogen in the diet, and how an excess of it, in the form of urea, reacts with the haemoglobin in the blood and reduces the blood's oxygen carrying capacity.

He says cows breathing hard is often a sign of too much protein in the diet, something they get from grazing pastures when they are all leaf and hence high in protein, rather than a combination of leaf and stalk, when the carbohydrate:protein ratio starts to become more balanced. The cows pant harder and harder in an attempt to get enough oxygen to their muscles.

A quick Google search corroborated the effect of urea on the blood, so there could be something in this. Also, I spent some time watching the cows today. They're grazing quite mature pasture, and even though the late June sun was blazing down, none of them were breathing hard or looked in the slightest bit distressed.

Except for the recently introduced bull, of course...

flagging up. Let me explain what I mean.

When cattle are housed, farmers normally study the animals' dung closely. Too loose and, assuming the animals are otherwise healthy, it's a sure sign of too much protein the diet. Too tight and dry and it's a sign there's too much fibre and too little protein. The ideal is a well-shaped cowpat of thick porridge consistency.

Self service at the mineral café

From www.mobgrazing.blogspot.com

Can cows self-select nutrients in just the right amounts to satisfy their needs? Having seen how they gorge themselves on barley, suffering acute acidosis and (in one case) death as a result, I would say not.

However, Mark Bader is a man who thinks they can, specifically when balancing their mineral requirements. Mark is President of "Free Choice Enterprises" and has carried out some fascinating work into the subject. His website can be found at http://www.freechoiceminerals.com/choose.php

The result of his hypothesis and subsequent investigations is that he likes to give cattle free access to fifteen different mineral formulations, plus salt. Greg Judy had one of Mark's self-feeders in with his cows. Interestingly, Greg says it was noticeable and measurable that the cows changed the types and quantities of each mineral depending on the paddock being grazed. Put them into an old, stockpiled paddock and the ratio of the amounts of each mineral consumed would be different from if they were grazing, say, a lush green pasture with seedheads just forming.

Mark Bader-designed a mineral self-feeder. The tray is covered with a heavy rubber lid, attached along the centreline of the feeder. The cattle soon learn to lift the rubber lid to gain access to the minerals underneath.

Mark argues that an excess of one type of mineral has serious consequences as it almost invariably locks up some other vital trace element causing a 'deficiency'. He makes the point that providing a 'compound, balanced' mineral block might actually be giving the cows too much of something and may be doing the cattle more harm than good.

It's an interesting theory and one I would love to explore further. I did think about putting some of Mark's minerals into my suitcase to try out here in the UK, but wasn't sure what Customs and Excise would make of a carrier bag of white powder stuffed between my dirty laundry and my wash bag....

However, when the cattle are turned out onto young, green pastures, the same farmers ignore the very green, very runny dung that is exuded in copious amounts by their livestock. The reason for the loose dung is exactly the same as when cattle are housed: there is too much protein in the diet with too little energy and too little fibre. The mob grazier recognises this and either saves some very mature grassland for early spring feeding or provides ad-lib straw to complement the high-protein grass diet.

The cattle know what is wrong with their diet. They will take the offered straw (or will hunt round the field margins, eating hedgerow plants and low trees) and immediately their dung will firm up and the sheen will return to their coats.

Mark Bader, an American nutritionist, also had another interesting theory about cattle health. This also involved the balance of protein and energy in the diet and the sub-clinical consequences of too much protein. He claimed that an excess of protein, once converted by the rumen microflora, could lead to

nitrite poisoning in the animal. Nitrites in the blood lock onto haemoglobin, displacing oxygen. The consequence is that the blood carries less oxygen and, taken to extremes, the animal dies. Mark explained that, at high levels of dietary protein (and hence sub-clinically low levels of nitrite poisoning), the animal's blood was simply short of oxygen forcing the animal to breathe harder. He said that farmers, on seeing their animals panting, often think the hot weather is to blame but, instead, he says it is often due to a dietary imbalance leading to high levels of nitrites in the blood.

Flies and parasites, both external and internal, are also a menace under conventional farming practices but can be much reduced under a mob grazing regime. One of the main reasons is that the cattle are constantly being offered clean, fresh grazing where the parasite burden, due to the passage of time is extremely low to non-existent. In addition, many of the parasites lurk in cattle dung and, as mob graziers don't force their animals to crop the grass close to the ground, the animals are only eating the cleanest part of the plants.

An unusual flytrap used by Durwood Gordon in Mississippi, USA. The dark colour replicates an animal's hide. The flies try to fly underneath the 'body' and the transparent sheets below guide them instead into a liquid-filled trap. Durwood placed it in the 'laneway' used by the cattle to move from one block to the next, so cattle would brush past it as they walked by.

When considering flies, many mob graziers claim that the regular moves mean that, by the time the flies' larvae hatch, the herd is a long distance away and so the overall fly burden is much reduced. I have to admit to being slightly sceptical about this assertion: I have seen no noticeable reduction in flies, even when moving cattle very regularly. However, this may be due to the layout of the fields here, where the cattle rotate in a broadly circular motion so are never a great distance, linearly, from earlier-grazed ground.

A word of caution about treating flies and other internal parasites: try to avoid using Ivermectin-based treatments. There is compelling evidence that these products pass through the animal and contaminate the pasture. Certainly from my own and other people's observations, the dung pats of cows treated with ivermectin and other potent wormers will just sit on the surface of the land, untouched for many months. Dung pats from untreated animals, however, are teaming with dung beetles, insects and earthworms and are scratched and scattered by birds hunting this rich bounty. Consequently, the latter disappear in a matter of weeks.

Bull Management

Greg Judy doesn't castrate any of his bull calves, instead leaving them all entire. He also leaves them running with the herd until they are twelve months old, only weaning them in the week that calving starts, on 1st April each year. He doesn't wean any of his heifer calves at all; they continue to run with their dams even after she's given birth to another calf.

Once weaned, the yearling bull calves are mixed with the previous year's bull crop and run as one big group. Come service time (July 1st), the *whole group* of bulls is put back in with the cows. In Greg's words, it's farming in nature's image, where the biggest, strongest and most healthy bulls serve the majority of the cows and heifers. Additionally, the heifers all calve at two years old and, as a bonus, with so many males running with the herd, the calving pattern is extremely tight.

A group of bulls being moved to a new paddock on Greg Judy's farm in Missouri, USA in early spring, 2011. Predominantly South Poll, they're a range of ages from freshly weaned yearlings to over two years old.

He says the bull calves don't get the heifers or cows pregnant before they're weaned. He didn't offer an explanation as to why, simply saying it doesn't happen in nature so why

would it happen with him. I suspect one of the reasons was because his cattle were outside through the winter, and with next to no supplementary feeding of any kind, especially no corn, the sexual maturity of his animals was delayed. Once again, it's farming in nature's image!

I'm not sure if I endorse what Greg is doing (maybe this is one of my own paradigms which needs to be broken down), though I certainly respect him for pushing the boundaries of our knowledge.

What I do commend is the idea of keeping all the cattle in one group and putting in enough bulls in one go to complete the service within as short a timeframe as possible. Numerous farmers and ranchers I met were doing just that and suffering few downsides. There are a few risks, of course: mixing bulls does lead to some tussling as they work out their pecking order and it is possible that one or more may be injured in the process; it's not possible to determine who the sire is without a DNA test; nor can you match a bull to a particular cow. Both of the latter may be important considerations for the pedigree breeder. However, for the commercial beef farmer, simplifying the breeding system in this way does seem to offer many benefits and should be embraced.

Since I got back to the UK, I've tried it myself. All three bulls were put into a herd of 130 cows and heifers. Initially they fought with each other to establish a pecking order and it took a couple of weeks for them all to settle down. As I write, 18 days into the service period, all three bulls are happily co-existing in the same high density mob-grazed group of cattle and all three appear to be working satisfactorily. Of course, the proof of the pudding will be when we scan the cows for pregnancy; only then will we know how well the bulls (all fertility tested prior to use) actually did during the service period.

Performance figures

I was very impressed with the grasp farmers and ranchers had on how well their livestock were performing, with several key data being used to monitor the performance. 'Animal days per acre' was widely used by holistically-managing mob graziers to measure the forage production of different pastures (see page 18) and is a useful calculation I have adopted here in the UK.

In Argentina I met producers who knew exactly how much weight gain, in kilogrammes of liveweight gain per day, they could expect from different crops at different times of the year. For example, Patricia Coll knew that in winter, whilst grazing autumn-sown oats, her steers would put on frame but no growth, being in a 'store period. Conversely, at turnout onto fresh grazing in the spring, they would gain up to 1.2kg/hd/day as compensatory growth and the higher plane of nutrition kicked in.

Weaning weights were also considered to be a key benchmark figure to show how well the dam and the calf had performed. The target for the Argentinian farmers I met was for the calf to be 45% of its dam's weight at weaning at six months old.

A group of Argentinian farmers I met, headed by Fernando Pacin, was using satellite imagery to determine grass growth – no more walking the fields with plate meters for them! Instead, using data freely available and available for free, they had developed, in conjunction with the University of Buenos Aires, a programme to interpret the infrared spectroscopy readings as levels of grass and other plant cover on a kgDM/ha basis. This allowed them to plan ahead in deciding where, and for how long, the cattle should graze and was yet another example of the impressive level of detail entered into by the farmers and ranchers I met on my travels.

Livestock in the Arable Rotation

From a holistic viewpoint, proper mixed farming is, to my mind, the holy grail, the natural fertility from the cattle feeds the soil, providing nutrients for the ensuing cash crops. The dung is converted into soil organic matter, stabilising the soil and improving its structure leading, in turn, to soils with greatly improved water infiltration rates and water holding capacity. By-products from the arable crops can be utilised by the cattle and converted into valuable proteins. It is the reason why, for hundreds of years, UK farms were mixed farms.

In recent times, however, all this has changed. The profitability of artificially-fed cereal crops coupled with the declining skill base needed to keep animals has led to specialisation on a

A Man with a Mission

From www.mobgrazing.blogspot.com

Gabe Brown is an incredible guy. One of the reasons (but not the main reason) is found in his love and understanding of soil - or as he calls it the 'resource'. Gabe is focussed on improving the soil of his farm in North Dakota. He has a thorough understanding of what makes good soil and puts a lot of thought, time and energy into improving his 'resource'. Mob grazing is just one of the tools he uses. Cover crops are another. I will explain more in a later blog.

However, there is something else, something far greater, which makes Gabe a truly outstanding person. He advises farmers across the US on how to improve their own resource. He speaks at countless conferences; he answers emailed questions; his telephone is called twenty or thirty times a day by farmers wanting to pick his brains. And he does all this for free! He refuses to take payment, other than to cover his out of pocket expenses and is convinced that he was put on this earth to spread the message, to disseminate his knowledge to farmers and thus to improve the soil of the world.

The origins of his 'calling' lie in his experiences during his earlier years of farming. At the time, he was a conventional farmer, highly mechanised and reliant on high levels of artificial input. However, as many may remember, farming was in the doldrums and Gabe will freely admit that he was all but broke, exacerbated by losing four years of cropping in a row as a consequence of extreme weather conditions (hail, drought etc). He reached the point where he didn't even have enough money to buy the fertiliser for the crops one year, and realised that shortly he would be out of business.

As a last throw of the dice, he planted some legumes to add natural fertility in lieu of the missing artificial fertiliser. To cut a long story short Gabe, being an observant and intelligent man, realised that the legumes not only improved fertility, but also had an impact on the soil health and consequently the water cycle. Thus began his long experiment which continues to this day.

Gabe's understanding of soil and its needs is amazing. He talks in terms of the carbon:nitrogen ratio (10:1 is optimum) and of the balance between bacteria and fungi in a soil (cultivated soils are predominantly bacterial with very little fungi - there is a strong correlation between high bacterial/low fungal levels and high incidence of crop disease; such soils also encourage annual weeds to grow, to the detriment of the crop. If we increase the soil fungi levels, the crops become cleaner and healthier). He now farms organically and is achieving yields only slightly less than conventional farmers, but with massively lower costs so his bottom line, as he openly tells anyone who asks, is (like his soils) in rude health.

This is testament to a good man doing a thoroughly good job.

vast scale. By and large, land that can be ploughed has been ploughed and vast tracts of the UK, especially in the drier eastern side of the country, have nary a ruminant animal on them.

It is different in other parts of the world and I was desperate to find out why. What makes other countries able to include cattle within their arable rotations and how and why do they do so? I met a couple of excellent practitioners, Gabe Brown and Jay Fuhrer in North Dakota, who gave me real insight into combining mob grazing and arable rotations. Following on from these visits, the most obvious destination to investigate this further was Argentina and so, in March 2012, I headed to South America for the first time.

Grass v Crops

As I write, prices for arable crops here in the UK and worldwide have risen significantly, driven by drought across the US, wheat disease pressure and quality issues in Northern Europe and lower wheat crop areas in the Southern Hemisphere. Based on a pure gross margin analysis, it is not easy to make the keeping of cattle on cropping land stack up.

Conventional Farm Rotation – Argentina

From www.mobgrazing.blogspot.com

The rotation, as Alejandro [Coll] explained to me over a 'two-steak' lunch, is based on an eleven-year cycle. During the first three years, the land is down to pasture. For the next eight years, a rotation of winter wheat followed by spring sown sunflower (or soya) is practised, with oats being planted during the winter period following wheat (and hence preceding the sunflower) for grazing with overwintered steers - effectively double cropping the land in those periods.

However, gross margin analysis fails to take into account many of the hidden benefits, and real financial savings, of integrating cattle into the arable rotation and I will expand on these through this section of my report.

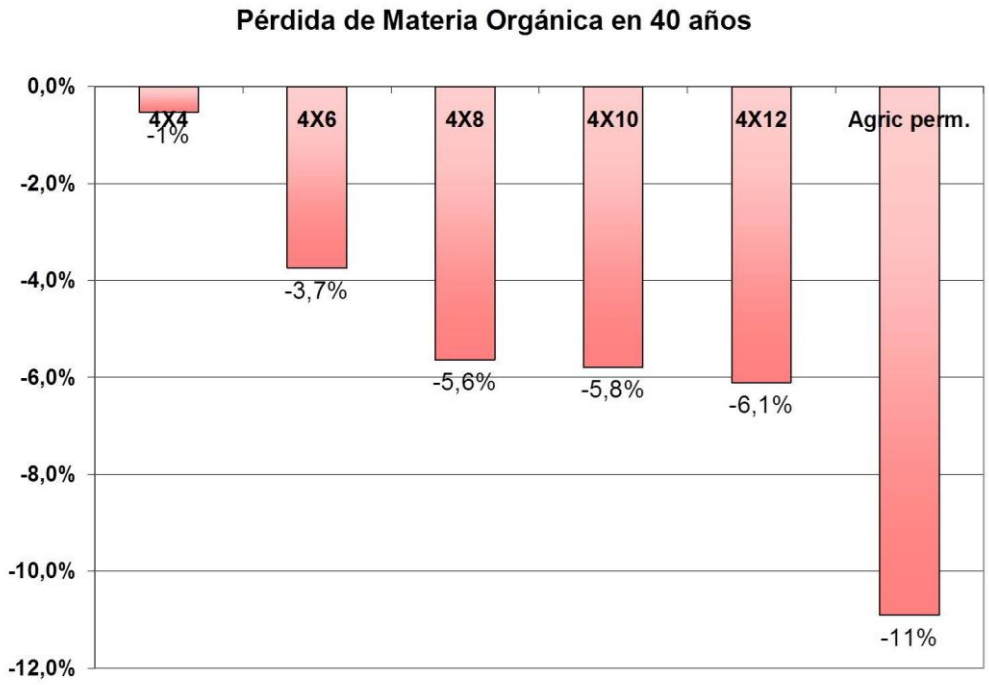
Different farmers had a different take on how much benefit was conferred onto arable land and, importantly, how long this benefit lasted. As the cropping rotation from Patricia & Alejandro Coll's farms in Southern Buenos Aires (yellow box, above) demonstrates, they felt a three year grass break was sufficient, on their soils and in their climate, to improve the ensuing arable crops for a further eight years, albeit with alternate winter grazing during the cropping period on oats planted for forage. By contrast, Diego Fontenla's organic farming business (left) felt the crop yields showed benefits for five years following a five-year grass break. Neither of these farmers was mob grazing although both were rotating their cattle round the farm to rest pastures. I believe if they did adopt mob grazing, with its capacity to increase rapidly the organic matter of the soils, then their crops and soil fertility would be enhanced even more than it is currently.

Organic Farm Rotation – Argentina

From www.mobgrazing.blogspot.com

Diego [Fontenla] explained that, within his rotation, he discovered that crop yields were maintained for approximately five years following the pasture cycle. Beyond this, they tailed off rapidly, hence his 5-year cropping followed by five years of pasturing of the land. Stretching the cropping to a sixth year meant smaller profits under his all-organic system

Fernando Pacin, another Argentinian with a deep understanding of combining cropping and livestock, was able to provide some hard data to back up the practical experiences of Diego and Patricia.

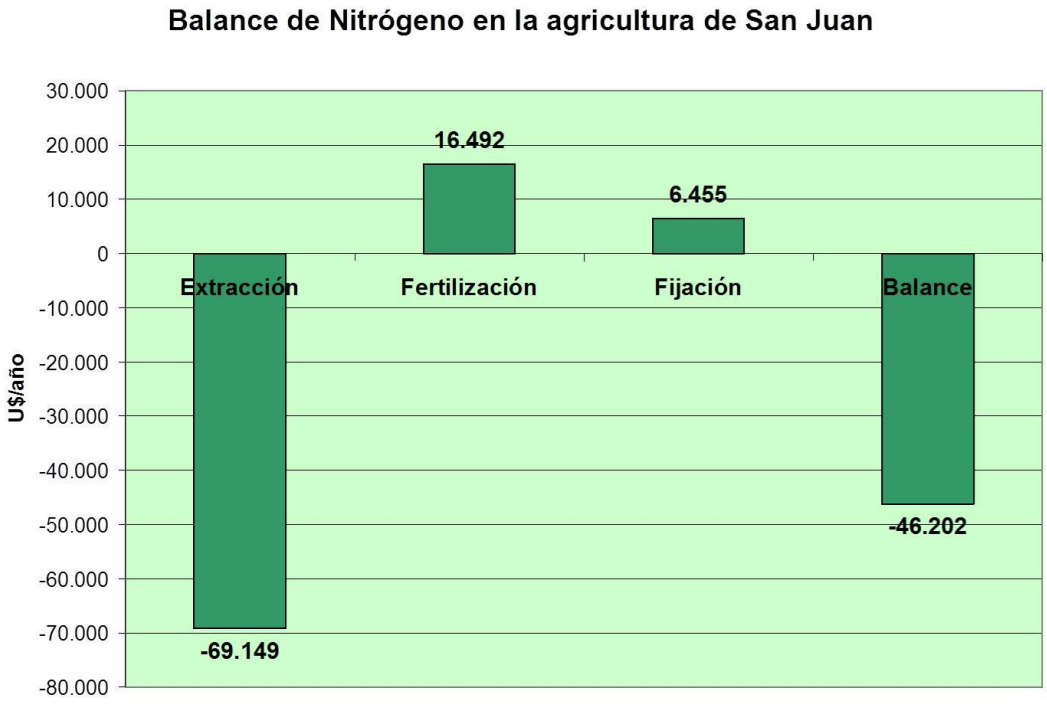


The forecast change in soil organic matter over a 40-year period under different regimes ranging from 4 years pasture followed by 4 years of cropping (left hand side column) to permanent cropping (right hand side column), as provided by Fernando Pacin. Although all systems result in declining soil OM, the rate of decline is least when cattle are included in the rotation for 50% of the time. Cattle were managed conventionally rather than being mob-grazed so none of the additional benefits of the latter were reflected in these results

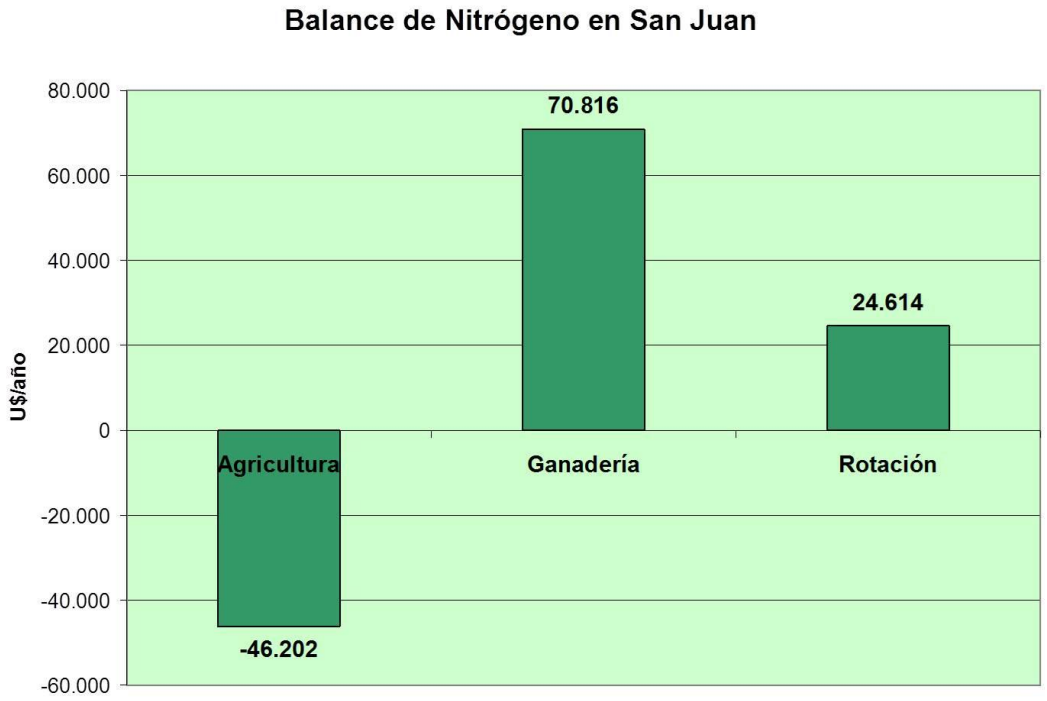
As explained earlier in my report, organic matter is vital for a whole host of reasons. It is the life blood of the soil and feeds the numerous living creatures that live in the subterranean world as well as providing the building blocks to help form well-structured soils.

The make-up of the forage species is of equal importance when considering the rotation-wide implications of combining livestock and arable enterprises. Including nitrogen fixing legumes such as clovers and lucerne (alfalfa) in the forage sward can result in real savings for the following crops: for the first two crops following a legume-based pasture, Fernando Pacin didn't need to apply any additional nitrogen fertiliser, thus achieving massive cost savings. This is an example of the hidden benefits not being conveyed if you look solely at the gross margin of the cattle grazing the land.

Fernando regularly prepared nitrogen 'budgets' to demonstrate how much nitrogen was either deposited or absorbed by the different cropping and livestock enterprises. As the graphs below demonstrate, when valued correctly the nitrogen deposited by a mixed rotation has real worth. Being locked up in the soil OM also means it is much more stable, less prone to leaching and is released slowly each year as the OM fraction breaks down.

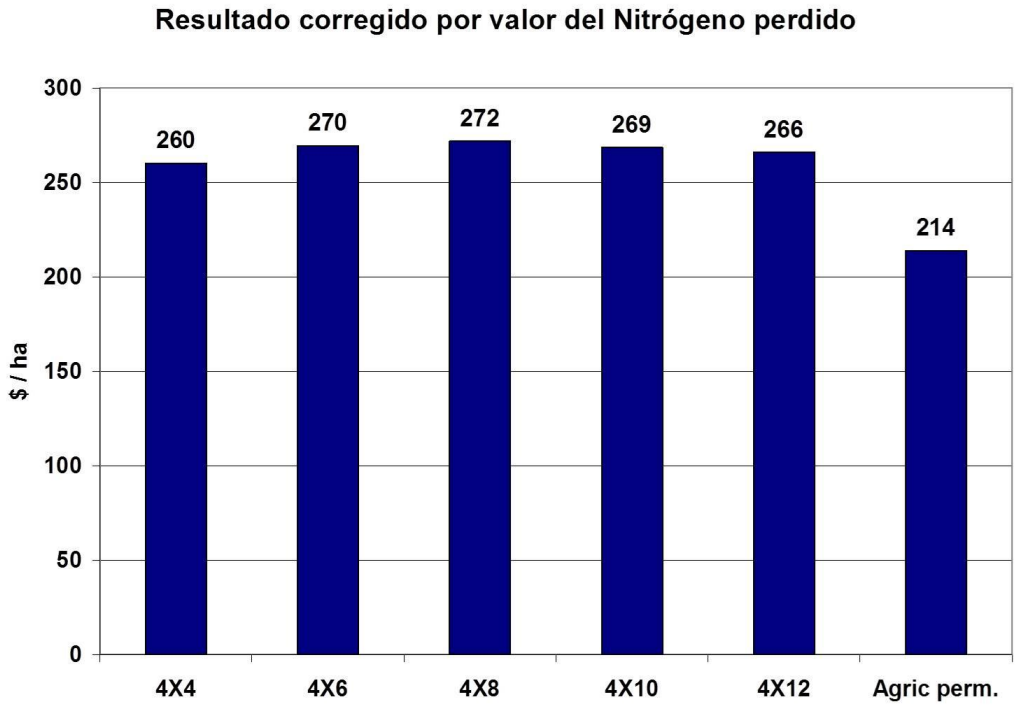


*An example of the nitrogen balance for the **arable crops only** on the farm known as San Juan in Argentina. The crops use $69,149-worth of nitrogen per year. The farmer adds $16,492 as artificial fertiliser each year and the crops (soyabean) fix $6,455-worth of N into the soil, leaving an annual nitrogen deficit valued at $46,202*



This is the nitrogen balance for the whole farm. The left hand column reflects the $46,202 annual deficit in nitrogen on the cropped land (see graph above). However, the livestock enterprises leave residual nitrogen in the ground with a value of $70,816 (from N-fixing legumes etc) meaning in the rotation as a whole there is surplus nitrogen, locked up in the soil organic matter and humus fraction, valued at $24,614

Fernando had also calculated the gross margins per hectare obtainable over the whole of the rotation for a number of different scenarios ranging from 4 years pasture followed by four years cropping through to permanently cropped land.



The average gross margin, in $/ha, obtained over the life of the rotation under various different combinations ranging from 4 years of pasture followed by four years of cropping to 4 years of pasture followed by 12 years of cropping, with permanent cropping (far right column) also shown.

As the above graph shows, from a financial point of view, there is little to choose between having a ratio of 1:1 pasture to cropping and having a ratio of 3:1, with a ratio of 2:1 giving marginally the best financial gross margin at $272/ha.

What is most noticeable is that continually cropping land and having no pasture or livestock breaks within the rotation (far right column headed “Agric perm”) actually leads to the lowest average gross margin of all systems. This clearly highlights the ‘hidden’ benefits of livestock within an arable rotation.

If we also factor in the changes in soil organic matter, and hence the ‘ultra-long-term’ sustainability of the farming practices, then the arguments for including cattle in the arable rotation become even more compelling.

There is a final consideration, pointed out to me by Fernando. As we are all very aware, farming has to deal with fickle weather and volatile markets. This means that profitability can swing dramatically from year to year. When livestock were present on cropped farms, that swing in the average net margins was much reduced – they too find the old saying

"corn up - horn down" to be true and the damping down in volatility can be a great help when planning future investments.

Cocktail Cover Crops

The Argentinian farmers I met put great emphasis on a legume-based forage break crop with its potential to fix nitrogen. Often the stands were pure lucerne (alfalfa) or a mix of lucerne and grasses, usually cocksfoot and fescue.

They were getting truly great results from such mixtures and were evidently very happy with their performance. However, in the US I was fortunate enough to meet up with two of the people at the forefront of practical on-farm research into the benefits of 'polycultures' (as opposed to monocultures or even simple two-or three-species mixtures) where lots of different types of plants were grown together, to be mob-grazed.

The leading practitioners I met were Gabe Brown, a farmer from North Dakota and Jay Fuhrer and his team from the Natural Resources Conservation Service (NRCS) in Burleigh County, North Dakota. Jay and Gabe work closely together, developing cropping combinations designed to feed and improve the soil as well as providing excellent nutritional qualities for the grazing cattle.

One of the first principles

Menoken Farm

From www.mobgrazing.blogspot.com

Menoken Farm was purchased by NRCS a few years ago as an experimental farm in which to practice what the NRCS team are preaching. Jay [Fuhrer] has been experimenting with cover crops, animal impact, mixed cropping, compost and compost teas, no till, no fertiliser, no fungicides, in fact a whole range of different things.

As Jay explained, it's all about putting carbon back into the soil. He says soil is like a bank, you must balance your withdrawals (of carbon) with your deposits. Unfortunately, for decades, farmers have been withdrawing carbon from the soil and are now totally reliant on artificial inputs to grow their crops. This is unsustainable in the medium to long term, being heavily reliant on oil and diminishing natural resources.

We need to learn how to put something back into the soil. Cover crops, and livestock, both do this very efficiently.

At Menoken Farm, Jay had a range of experiments underway. He was growing a mix of cover crops and/or cash crops. His intention was to try to find how quickly the land healed itself (with the cover crop designed to put back carbon in the soil; the animal impact designed to stimulate biological activity) and how many 'withdrawals' a farmer could make (ie growing cash crops) before more healing cover crops were needed.

Jay doesn't go anywhere without his trusty spade. Very quickly, he was digging samples from the ground, showing the difference between soils with no organic matter added and soils with just one year's cover crop.

Now the soil at Menoken was basically sand. On the untreated land, it was a pale grey colour, and fell apart at the slightest touch. There was no carbon and hence no glomalin and hence, no structure to it. Alongside it, the soil that had been cover cropped/grazed for a year was darker in colour. It was starting to hold together too, not terribly well but noticeably better than the untreated soils. And this was after just one year.

On land that had been fed and undisturbed for longer, the peds (clods) were stronger, the soil darker in colour. He was also finding that, as the soil health improved, residues broke down more quickly.

behind growing a cover crop is that the harvesting of sunlight is no longer terminated at harvest time. Under conventionally winter-drilled monocultures, as soon as the crops start to senesce, the sunlight is wasted and continues to be wasted until long after the new crop emerges. This is at a time, mid- to late-summer and early autumn, when the sun is at its strongest, days are at their longest and huge amounts of sunlight are streaming down to earth every day. Cover crops, vigorously growing at this time, soon raise the green area index and efficiently capture this sunlight.

Blending different types and species of plants into a so-called 'cocktail cover crop' takes the benefits to an even higher level. The reasons are many and complex; I will try to explain some of them as I understand them.

As with mob grazing, the thinking behind growing a cocktail of cover crops is that it is trying to emulate what happens naturally. It is, once again, 'farming in nature's image'. In natural environments, you almost never see monocultures. Instead, a whole host of different plant species will grow together, each occupying a different niche in the environment, sometimes competing but often coexisting side by side to mutual benefit.

Practitioners growing cocktail cover crops are finding the same. Each type of plant has different growing habits and confers different benefits as a result. For example, millet is a shallow rooted warm-season (ie C4) grass which has a low water demand, is good at increasing soil organic matter and provides good weed suppression. It also has a moderate C:N ratio (see page 11). By comparison, sweet clover is a cool season (C3) broadleaf legume with medium-depth roots which has a medium water demand. It is classified as only average at increasing soil organic matter and suppressing weeds but, as well as its N-fixing properties, it has a low C:N ratio so breaks down in the soil very quickly.

Jay & Gabe explained to me that they were finding the ideal mixture would contain at least three or four plants from each of four different classifications, namely:

- Cool season grasses *(eg barley, rye, wheat, oats, triticale, cocksfoot, timothy)*
- Warm season grasses *(eg maize, millet, sorghum, sudangrass)*
- Cool season broadleaves *(eg lentil, pea, forage radish, sugar beet, sweet clover, turnip)*
- Warm season broadleaves *(eg buckwheat, cowpea, hairy vetch, sunflower)*

By blending them, the resultant root exudates from the root mass feed myriad different species of soil organism, each adding their individual qualities to the overall soil structure and health. The mixtures appeared to have other advantages too, breaking disease cycles and reducing pest levels and the overall health of the plants in the mixture was greater than if each species was grown in a monoculture stand surrounded by its own type.

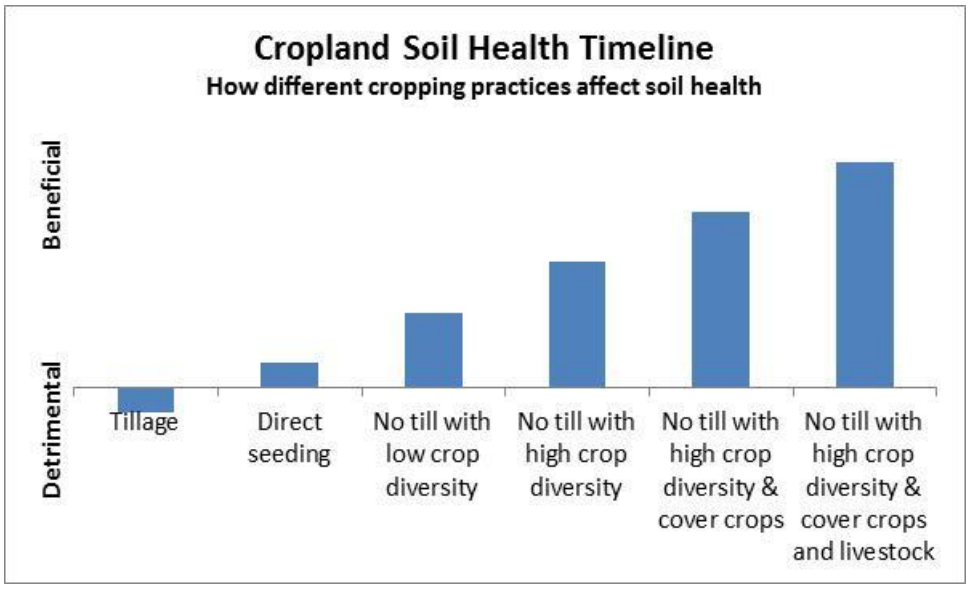
As intimated above, the different crops in the blend can be selected depending on what you are seeking to achieve from the mix. For example, forage radish is recognised as an excellent

plant for busting through compacted layers such as plough pans. Its long deep tap roots force their way down into the subsoil, capturing nitrogen and other nutrients in the process. Cereal rye, on the other hand, will provide huge amounts of above-ground organic matter and is a quick growing, winter-hardy grass.

Animal Impact

In all cases, whilst cover crops on their own will do a very satisfactory job in improving soil structures, especially if direct drilled (rather than the soil being cultivated), the addition of animals – so-called 'animal impact' – will enhance the benefits even more.

Jay has a 'cropland soil health timeline' which he uses to explain which practices are most detrimental and which are most beneficial to soil health.



As this demonstrates, Jay believes the greatest benefits are obtained when crops are direct drilled, there is high diversity in the rotation, in addition there are cocktail cover crops used within that rotation and these cover crops are mob-grazed with cattle. If you can achieve all of these things, then your soils will be in rude health and the crops you grow in them will also be healthy and high yielding.

Winter grazing

A lot of the mixed farms I saw, especially in Argentina, grew autumn-sown cover crops to feed the livestock through the winter followed by spring-sown cash crops for combining later that year. Effectively they were double cropping the land as well as reaping the benefits of incorporating livestock into their rotation on a regular basis.

Crops grown for winter grazing varied according to the region and, as far as I could tell, local traditions. Amongst the most common were oats, rye and sorghum. In virtually all cases (except on Diego Fontenla's organic farms, where weed control was equally important) crops were direct drilled into uncultivated soils.

This practice of direct drilling offers several benefits: The soil structure is undisturbed so is better able to handle livestock during the winter months; the crop is established more quickly following the combine; very little moisture is lost from the soil compared to cultivated land thus also speeding up crop establishment; costs of crop establishment are much reduced hence it becomes even more economical to double crop land in this way.

Winter-feeding Sorghum

From www.mobgrazing.blogspot.com

On intermediate land which is not quite good enough for cropping but is more productive than the poor quality soils of the permanent pasture land, Patricia [Coll] includes sorghum in the rotation. This is an important winter feed for the cattle and, despite being killed off by the first frosts of the winter, retains sufficient nutritive value and, more importantly, dry matter bulk to sustain the cows during the three months.

Patricia was told that one hectare of sorghum would sustain 100 cows for 1 week. When she first tried it, she got nowhere near to this level of stocking before the feed disappeared. However, after discussing it with other practitioners, she adjusted the method of feeding and now gives the cattle access to it for four hours a day only. This is sufficient for them to fill their rumen. For the remaining 20 hours they are brought off the field and kept in a corral with only water available. This ensures they eat what they need without gorging and/or trampling/dunging/wasting any plants.

As well as providing winter feed, this technique also keeps the cattle away from the grazing pastures, giving the grasses valuable time to recover. When the early spring calving starts, the pastures are refreshed and growing away nicely, providing a good source of nutrition for the cow and growing calf.

Infrastructure

Cattle have been absent for a long time from the majority of arable farms in the UK, especially the drier eastern regions of the country. Consequently, much of the infrastructure – including fences, field gates and water troughs – is missing from the land. This could be seen as a significant hurdle to the successful reintroduction of cattle into arable rotations here in the UK.

However, this is not insurmountable and I witnessed, on many of the farms and ranches I visited, ingenious ways to overcome such difficulties.

The greatest boon to handling livestock in modern times has been the invention and use of electric fences. Powerful energisers are available to provide sufficient charge to cover hundreds of miles of electric fencing. High tensile wire can easily be erected around the field boundaries to carry this charge to all corners of the holding. Gateways can be made using spring-coil gates which are easy to open and close. Temporary fences made of braid carried on 3:1 geared reels and push-in posts allow paddocks to be subdivided quickly and easily and these can be connected quite simply to the more permanent high tensile wire.

The beauty of electric fencing is that cattle very quickly learn to respect it and, unless they are particularly hungry, do not put pressure on it or try to break through. In a mob grazing scenario, the cattle are moved so frequently and onto such high levels of new forage cover, that they are never hungry and so it is simple to keep them contained.

Chad Peterson in Nebraska originally built his fences to contain the buffalo he farmed at the time. He used two strands of high tensile wire, the first one at 24 inches off the ground and the second one at 48 inches off the ground. He believes that, even with animals like buffalo which are renowned as good jumpers (no, I didn't know that either), two wires at these spacings will keep the animals in the field.

Chad Peterson's solar powered energiser and two strands of high tensile electric fence, mounted on a naturally-insulated fibreglass post. The beauty of these posts is that they can be drilled into and have the live wires attached directly, without the need for any insulators

Fence posts, too, can be spaced far apart with high tensile wire as they only need to keep the wire off the ground. Unlike a conventional fence, there will be no animal pressure on the wire itself and therefore the posts don't have to be close enough together or thick enough to support such pressure.

This means that dozens of kilometres of semi-permanent high tensile wire can be erected in a very short period of time and a farm can soon be converted to being 'cattle ready', from a fencing point of view.

Water is a different matter and an animal's water needs will vary depending on its age, whether it's in calf or suckling a calf, the weather and the condition of the grass being grazed, to name but a few. There are various options for watering cattle within an arable holding and I discuss some of them below.

The first option is to use a large mobile bowser and water trough which follows the cows from paddock to paddock. Obviously this ensures the cattle have a good supply of water though the downsides are that the bowser can take a long time to refill and it also needs a tractor or other vehicle to move it from paddock to paddock. The moves can be reduced by having an umbilical pipe to the trough itself, meaning only the trough needs to be moved regularly which could be done by hand. It is also prone to freezing during the winter months.

A more practical, long term solution would be to mole plough pipework in from the mains or other water source and put troughs into the fields as required. This overcomes the need to refill the bowser and, with quick-release valves, could make the provision of water a simple task going forward.

On many farms there are also reservoirs, rivers and dykes which could also be used to water the cattle. The water could either be pumped out or the cattle could be given direct access to the water source. Ideally, assuming there is sufficient fall on the head of water, a ram pump could be used. These ingenious inventions use the pressure created by the head of water to lift small amounts of water several times higher than the head of water itself, whilst using no electricity or other power source. Alternatively, a solar-powered pump could be used or, less sustainably, a tractor-driven pump.

A natural spring in Paraguay fenced off to prevent cattle entering the water and damaging the banks. The cattle can reach through the wooden rails to drink from the pool formed with reclaimed house bricks

Giving the cattle direct access to the water can cause problems with bank erosion, water contamination and cattle health problems. Various solutions were offered to avoid or reduce this, from fencing and allowing partial access to the water (as practised variously by George Brizuela-Kirk in Paraguay and Ben Coleman in Missouri) through to gravity-fed troughs below the main reservoir.

A fenced watering pond on Ben Coleman's farm in Missouri, allowing cattle partial access to the water with the pond base strengthened with hardcore tipped on the access area

Cattle Management and the Arable Farm

A final major hurdle to including cattle within an arable rotation is the lack of available skills within all-arable farm businesses. Keeping cattle and good stockmanship are far removed from growing combinable and root crops, both in the type of skills required and the workload, the latter being ever-present, to a greater or lesser degree. Mob grazing is designed to reduce the workload to the bare minimum but there is still the daily need to check the cattle to ensure they are fed, watered and healthy.

Arable farmers, quite understandably, often have little interest in or desire to become cattle farmers. However, I believe that this provides an excellent opportunity for new entrants and young farmers in the industry. There are vast tracts of arable land that would benefit hugely from the presence of cattle. By entering into a short-term leasing, grazing or herbage agreement, landowners and farmers could simultaneously reap the financial rewards of including cattle into their rotation and offer keen young farmers an opportunity to start a cattle farming business.

I have to declare an interest at this point! I too am very keen to be farming on my own account and believe this offers a genuine access point for me to expand my small herd. To this end, I am seeking both farmers who are keen to reintroduce cattle into their rotations and investors wanting to invest in the cattle that will occupy that land.

For investors I can offer a rate of return comparable to some of the best investments available on the open market at the current time, with the cattle securing the investment, whilst for landowners I believe I can offer returns comparable to existing break crops but with the additional benefits discussed above.

If anyone in Hertfordshire or the surrounding counties is interested in discussing this further, please telephone me on 07717 505287. I look forward to hearing from you!

Conclusions

The conclusions I draw from my study tour to investigate the potential of mob grazed cattle to be the perfect arable break are:

1. Well planned mob grazing of pasture by cattle will dramatically increase the organic matter within the upper soil profile leading to healthier soils, an improved water cycle and stronger, healthier plants. Consequently the overall productivity of the land increases because, as grasses are left to grow to maturity more sunlight is captured and converted into plant material, feeding the life both above and below the soil.

2. A well planned mob grazing regime using the correct breed of cow will shorten the amount of time cattle need to be housed during the winter, significantly reducing associated costs and dramatically improving the overall profitability of the enterprise.

3. There is clear evidence that including livestock within an arable rotation can improve the overall profitability of the business. Whichever measure you use, be it soil health, crop health, water infiltration, drought tolerance, overall crop yield or financial returns, the benefits are clear to see and last for several years after the land has returned to cropping.

4. Growing a cocktail of different plant species and then mob grazing them maximises the soil improvements achievable and returns the most sustainable profitability within a mixed arable-livestock rotation.

Recommendations

Following my study tour, I would make the following recommendations:

1. Livestock farmers should group their cattle into fewer, larger groups and should subdivide their farm into smaller paddocks, aiming to stay in each paddock for as little time as possible and in any event not more than three days. Additionally, they should look to lengthen the recovery time given to the grass plants before they are re-grazed.

2. All expenditure within a livestock enterprise should be questioned. Many of the costs we deem as necessary are only so because we are caught in our own paradigm. Winter housing costs are a prime example of this and livestock farmers should use a detailed grazing planning model with the main aim being to extend the summer grazing period.

3. Cattle should become an integral part of all arable rotations. Overcome issues such as lack of skills by entering into business relationships with keen young farmers who are looking for a foothold into the industry.

4. Consider carefully the rotations in the light of the inclusion of cattle. Planting cover crops in the autumn for grazing during the winter, followed by a spring combinable crop, may give greater overall profitability than a continuous three or four winter crop rotation. It will certainly enhance your soils and will also be beneficial to wildlife and the environment

Postscript: After My Nuffield Study

During our first week as true 'Nuffields', great emphasis was laid on the fact that our forthcoming study tour was not just an opportunity to investigate a topic we were passionate about. It was also an opportunity to discover ourselves, to find out what makes us tick, to go on a voyage of self-discovery.

Well, that's how I interpreted the message anyway!

It has been a truly momentous voyage. There have been many ups, a few downs, lots of good times and the occasional average moment! What there has been, more than anything, is a lot of soul searching. I've realised many things about myself, some of which I'm proud of, quite a few things I need to change and none of which I'm willing to commit to type here!

From a business angle, what I have realised is that I am more passionate than ever about farming. I took a step closer to the industry when I set up my own consultancy firm five years ago. I now want to accelerate my involvement in the cattle business and am actively seeking both investors and arable farmers with whom to deal. I have restructured my current workload to give me more time to do this and am starting actively planning my next moves.

I said in my introduction to this report that I have "visions of vast herds of ruminants mob-grazing their way across East Anglia, adding natural fertility to the hungry soils and making farming more sustainable". I want to be part of this vision and want to make it happen. That is my dream and is the legacy Nuffield has left me with.

Acknowledgements

There are many, many people who have contributed directly to my study tour and without whom much or all of it would have been impossible.

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An equally big thank you is extended to the John Oldacre Foundation. They provided the funds which allowed me to realise my dream and I hope this report does their generosity justice.

John Stones, Nuffield Director, was always available with advice and guidance. His early briefing to us set out what we should expect from our travels and his words often echoed in my ear when I found myself in unusual or slightly precarious situations! Thank you John, and good luck with your career post-Nuffield.

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Chad Peterson & family, Nebraska
Doug Peterson, Missouri
Ben Coleman, Missouri
Sledge Taylor & family, Mississippi
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Gustavo Fettamanti, Rosario
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