A Nuffield Farming Scholarships Trust Report

Award sponsored by

The Trehane Trust and Dartington Cattle Breeding Trust

Achieving more from less with dairy and arable collaboration

Johnny Alvis

November 2015

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NUFFIELD FARMING SCHOLARSHIPS TRUST (UK)

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A Nuffield (UK) Farming Scholarships Trust Report

Date of report: November 2015

"Leading positive change in agriculture. Inspiring passion and potential in people."

Title	Achieving more from less with dairy and arable collaboration
Scholar	Johnny Alvis
Sponsor	The Trehane Trust and The Dartington Cattle Breeding Trust
Objectives of Study Tour	To see if collaboration can work; if technology from one enterprise can work for the other; and ultimately to see if both enterprises can benefit financially from working together.
Countries Visited	Australia New Zealand USA Poland Ireland
Findings	Collaboration will work; each party must share in the gain and the work load and each contributor's role must be clearly defined. Technology from the arable sector continues to be developed and used for the benefit of the livestock sector. There are clearly some areas where both enterprises can benefit both physically and financially from the arable department and the livestock departments working together.

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DISCLAIMER

The opinions expressed in this report are my own and not necessarily those of the Nuffield Farming Scholarships Trust, or of my sponsor, or of any other sponsoring body.

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1. Introduction

I live in Redhill, North Somerset, with my wife Jo and our three children, Victoria, Katy and J. Redhill is situated on the north side of the Mendip Hills and is a wonderful area for growing grass for dairy cows. Jo and I met whilst studying at Seale Hayne Agricultural College in 1988, and she works alongside me at Regilbury Park Farm.

Together with my brother, Peter, and father, John, we run a farming and cheesemaking business, with my emphasis being on the farming side of the enterprise. The business is producing 4500t cheese annually and currently milking 1100 cows on three sites. At present our cheese business is expanding, through export and home sales, and is looking for a greater milk supply. Our farms only supply 20% of the total milk requirement of 45 million litres annually. I am looking to substantially increase this.

My day-to-day responsibilities are running a 650 dairy cow unit with followers and a small beef unit, totalling approximately 1400 head and 150ha arable, which is usually destined for animal feed, although some will be sold in years of surplus. We have been under TB restriction for the last 21 years and have had to develop a system able to handle all cattle through to finishing, replenishing the dairy herd or selling into the restricted market. Our farming system has to cope with ever changing TB regulations.

For my Nuffield Farming Scholarship study I am looking to see how other people have expanded by using partnerships and collaborations with other farmers and land owners to make the best use of their facilities, skills and technology to create profitable enterprises.

Figure 1: J, Victoria, Jo, Johnny and Katy

2. Background to my study topic

My study topic: "*Achieving more from less with dairy and arable collaboration*" started as a straight-forward concept. It stemmed from our rebuilding a milking facility on a 200ha block of grazing. Initially this was done to reduce the milking time of our 350 cow herd, and to create an altogether better environment for our staff and cattle to allow further expansion in the future.

We now have a machine capable of milking up to 2000 cattle but only 200 ha around the dairy. "*Achieving more from less with dairy and arable collaboration*" would allow us to make the most of some expensive equipment and infrastructure that we have built.

All our milk goes to our own cheesemaking facility which is another part of the family business. This is run by my brother, Peter. Three years ago when the milk price began to climb we started to introduce more cows to the milking platform thus increasing the need for more winter - and some supplementary summer - feed, to be brought onto the site from off-lying land. To a large extent, our cows are grazed during the summer and housed in the winter. We have changed our calving pattern from all year round to spring and summer calving. Milk from spring and early summer grass gives us a better quality product for making cheese. There is also a small group of November calving cows to help maintain some winter and early spring milk. We are starting to build a herd of crossbred cows that are spring calving and milked once a day. These cattle make use of the grazing up to a mile and a half away from the dairy buildings. They are dried off in December and out-wintered off site on a mixture of turnips and other root crops as part of the arable rotation, and are not housed at all.

As the herd began to expand it soon became clear that looking after the livestock, their feeding and welfare was not an onerous task; but the need to move feed onto the farm and manure off to the arable land was becoming an important issue.

The strategy of milking more cows on one site and moving feed in and manure out would make the most of some expensive milking machinery and infrastructure. It would also enable us to stay more easily within the rules and regulations set out by government bodies regarding the amounts of manure, both liquid and solid, that can be applied. Moving manure away to the arable land will enable us to keep the 200ha around the farm for continual spring to autumn grazing, maintaining the optimal growing conditions for grass growth for grazing with any surplus being conserved for winter feed.

In the last three years the price of milk has risen to 34ppl and collapsed to 22ppl. This has really driven the need to cut more costs, make the most of on-farm resources and seek out technology to help with this. Whilst the extra milk production is not required at the moment it has focussed my mind on cutting purchased input costs in both the dairy and arable enterprises, and the two working together is a must. This needs to be measurable, repeatable and profitable, particularly to help ride the current milk price drop and to allow some serious production increase when the milk price eventually rises and worldwide demand increases.

3. My study tour – where I went and why I chose those countries

March 2014: Australia

I attended the Contemporary Scholars Conference (CSC) in Sydney and Canberra and then joined a post-CSC tour through New South Wales. We saw a large variety of agriculture, from cattle to cotton and sheep to wheat; plus some precision and innovative farming, particularly people dealing with dry land farming. After this I stayed in Australia travelling to Tasmania looking at various agricultural businesses and the University of Tasmania.

May 2014 Australia

Before joining the Global Focus Program (GFP) I flew to Adelaide and travelled through South Australia and Kangaroo Island. I saw collaboration at its best and worst.

May/June 2014 Australia and more

Global Focus Program[1]. Thanks to the Mercer family and Nuffield Australia I was able to join the GFP in Canberra, Australia and travelled through South and North India, Qatar, Turkey, Netherlands, France and USA.

August 2014 Poland

My daughter was representing Great Britain at the Junior European Carriage Driving Championships in southern Poland. During a rest day I was able to travel to Poznan and see 2 dairies and an arable enterprise.

September 2014 Ireland

I joined the Global Dairy Farm Tour of Southern Ireland with other Scholars.

October/November 2014 USA

I flew to Chicago, Illinois, then travelled through Wisconsin, Iowa, Pennsylvania and New York. I saw dairy, arable, beef and cheesemaking and spent some time at Wisconsin University.

January 2015 New Zealand , New South Wales and Tasmania, Australia

I travelled through North and South Island looking at precision agriculture, grazed and housed dairies, and saw how everyone deals with water and soil nutrient restrictions/issues.

I chose these countries for their varying dairy styles, all of which could, to a large extent, be repeated in the south west of England, and for their arable enterprises growing winter crops for

[1] The Global Focus Program tours (GFP) organised by Nuffield Australia provide an intense 6-8 week journey covering several continents. Participants are small groups of new Nuffield Farming Scholars from any of the countries in the Nuffield scheme, and the tours cover agricultural marketing, trade and environmental issues, plus the different social and cultural aspects of each region visited.

cattle. Whilst the climates are obviously different the *modus operandi* of farming systems can be very similar.

I was hoping to see farming on a larger scale than in north Somerset (where I live) and hopefully cooperation on a greater scale to cherry pick the best ideas and practices that could be bought back home and put into practice.

3.a. Working together

Looking at some dictionary definitions I found as follows:

> **Collaboration** – working with others to do a task and to achieve shared goals. It is a recurring process where two or more people or organisations work together to realise shared goals. (www.en.wikipedia.org)

Figure 2: Collaboration (*www.dreamstime.com*)

> **Partnership** – a business entity where two or more co-owners contribute resources and share in profits and losses and are individually liable for the entity's actions; a relationship between individuals or groups that is characterised by mutual co-operation and responsibility, for the achievement of a specific goal or goals. *(www.thefreedictionary.com)*

Figure 3: Partnership (*www.123rf.com*)

4. Collaboration - farmers taking the lead

Looking into relationships between dairy and arable it quickly became evident that a number of rules and regulations hamper some development and innovation. Farmer-led progress can and will always be more applicable than government-led regulation. It is imperative that farms and their supporting organisations take the lead so we in the UK do not end up with some of the draconian restrictions I have seen on my Nuffield Farming travels, some of which will be described in this report. I also feel it is important that legislative, environmental and agricultural organisations work together to provide a flexible and workable approach to any situation requiring a form of regulation.

The farming ethos appears to be, all over the world, to help a neighbour in strife. Nowhere was this more evident than on a visit to Lachlan and Di Smart's farm near Murray Town in New South Wales, Australia. They are farming 1700 acres of arable and 4000 head of sheep. In April 2014 a bush fire came through: they lost every acre of crop and 500 head of sheep. They managed to get the other 3500 penned into the sheep yards away from the fire. Even a month later the whole place reeked of smoke and was covered in soot but local farmers had taken on the remaining ewes with a '*pay when able'* approach, and had sent in labour to help re-fence.

Three weeks later a downpour washed out the new fences and filled the dams with soot, soil, burnt timber and fencing. Again the neighbours rallied round with diggers and helped to get them going again. This was evidence of farmers and their neighbours working together at their best.

A different situation but similar outcome was seen in the flooding in January 2013 on the Somerset Levels, where local and national farmers provided help and fodder for those overcome by the floods.

Figure 4: Fodder being delivered to farms hit by the floods on the Somerset Levels

5. Formal agreements

There are very few formal agreements that operate between farms that are designed to run for more than one growing season at a time. They virtually all rely on the financial viability and good will of those involved. The need for tolerance on behalf of both parties to meet the required aim is paramount. This can be particularly difficult when the weather is against the operation and the need to harvest, replant, remove residue, cultivate, spread manure - or whatever the next activity is - can become secondary to the ultimate aim.

Bill Morgan, of Scepia Farms in the State of New York, is milking 800 head of Holsteins which are housed all year round, and produce 11000l/hd/yr. His youngstock are reared off site. Bill grows 50% of his forage requirement and the other 50% is grown predominantly by one neighbour.

The brought-in feed is based on a 4 year rolling contract and a 4 year rolling price for maize (corn). This takes out some of the peaks and troughs in the arable enterprise. It enables Bill to maintain not only a consistent supply of his brought-in feed, but also to manage his conserved feed stocks from one year to the next. It enables the supplying farmer to plan his crop rotation and his crop nutrient requirements, knowing how much of his farm is tied up and how much crop is sold, and how much he anticipates selling on the open market. This is particularly advantageous from a cash flow planning point of view.

This arrangement is based on the margin made on a crop of maize corn grown for traditional combine harvesting. Bill provides the seed so that he gets exactly the type of maize he is looking for, and harvesting is undertaken by Bill's own contractor, although he is hoping to run his own machinery this year. There are no harvesting costs to the grower. This means the crop can be taken at whatever stage of maturity Bill requires.

There is more risk of soil compaction from forage harvesting, and the lack of harvesting cost to the grower is set against any extra fieldwork costs associated with correcting this compaction for the next crop. Manure is supplied to the arable farm from Bill's dairy and the nutrient value is credited against growing costs. There is no spreading cost to the arable unit; this is all covered by the dairy.

Figure 5: Wet maize harvest

This type of arrangement, in one form or another, is common throughout the world and requires a lot of goodwill and faith from both parties. It also requires that both parties are financially viable. If one of the agreement holders were to have financial difficulties it could impact on the other. In Bill Morgan's case he could potentially lose his forage crop and, in the arable grower's case, he could end up with a forage crop he is unable to combine to sell the grain, or a harvested crop he gets no payment for.

Whilst in this particular instance I am sure this will not happen, it is certainly worth thinking about the pitfalls that could arise from an arrangement such as this. There is also the opportunity to aid cash flow by spreading the costs and/or payments throughout the year. Again at best this has to be beneficial to both operations and certainly not detrimental to either.

Figure 6: Cattle feeding on contract-grown maize

6. The Wheatfield Grain Company

Nial O'Boyle runs the 2400-head Black Sands Dairy, Iowa, USA, and a feedlot operation which can house up to 2000 finishing beef and dry cows. The parent company is also building a 4000-head dairy. Heifers and whole herd dispersals are bought in to the dairy and any animal that is not performing as required goes onto the feed lot. This means there are fluctuations in the number of cattle held on site; this fluctuation in numbers will only increase as the number of milking cows increases.

Whilst Black Sands Dairy grows some maize, most is purchased through the Wheatfield Grain Company. This agreement allows Black Sands to purchase only what is required and so does not tie up money in feed when there are fewer animals in the lot.

Wheatfield Grain Holding LLC has created a silage/high moisture corn (HMC) contracting program. Primarily targeted towards the dairy and cattle industry, this allows dairy and arable farms to be financially independent and to price the portion of grain to the WGC whenever price is favourable for each entity. (*www.wheatfieldgrain.com*)

A portion of the forage crop is left unharvested and taken to grain stage and combined conventionally. This enables the price to be rectified and comparisons /adjustments made for the yield, where applicable.

Figure 7: A strip of maize left to mature in a field that was harvested for forage

Whilst it is unlikely for maize corn to be traded like this in the UK, as maize is usually grown as a forage crop and not a combinable crop, it would be possible to create a similar contract for wholecrop wheat, barley or forage maize. This could be a break crop for the arable grower, and would all be feed crops for the livestock farm. This could be costed by using the gross margin for growing wheat, to achieve a crop as profitable as wheat as a basis for determining the sale value for the harvested crop. The gross margin for any crop suited to the arable farm could potentially be used.

The gross margin for wheat at £120/t sale value, at a yield of 9t/ha, is £610/ha based on variable costs of £520/ha, leaving a margin of £90/ha. For this proposition to be viable would mean the margin added after all the growing costs of the maize or any other crop would have to be £90/ha. This does not take into account any environmental, SFP or any other non-crop specific inputs or costs. These figures are from the Rural Business Survey research.

There are a number of other points to be taken into consideration, particularly where maize is concerned. Firstly being a spring crop there is an option for an additional winter grazing or cover crop to be grown after the previous harvest and before the maize is planted. This can be added to arable enterprise income and potentially be set against the cost of growing the following maize. Secondly being only a 6-month crop realistically only half the land rental, or equivalent, value should be taken into consideration when determining the cost of growing the crop.

The value of maize for dairy farming is currently less than the value of maize going into anaerobic digesters. This is because of feed-in tariffs for the electricity and gas that is created, and the low value of milk.

There was no allowance made for moving manure from Black Sands Dairy and this was done on a gentleman's agreement with neighbouring farms and via their own farm.

The value of maize for dairy farming is currently less than the value of maize going into anaerobic digesters. This is because of feed-in tariffs for the electricity and gas that is created, and the low value of milk. As the number of these AD plants grows, this arable break crop for dairying will lose out to gas and electric production.

In the Netherlands, 3 of the farms that I visited had AD plants, 2 of which had been turned off after their initial 10 year government-assisted running period had expired. The 3rd AG plant, currently in year 9, is expected to be switched off at the end of year 10 unless further government assistance is forthcoming.

7. The New York Watershed Agreement

The Catskills Mountains, New York State.
2000 square miles, 9 reservoirs, 3 control lakes, 550 billion gallons of water storage.

Figure 8: Watershed Agricultural Council logo

All the water for the 9 million population of New York City arrives fresh, untreated and unfiltered, by gravity from the Catskills area of New York State. The New York Watershed Agreement is a voluntary sign-up of the Watershed Agricultural Council (WAC) which, whilst not production driven, is a very good example of what can be achieved when all involved parties get together, and clear objectives and decisive actions are set and taken.

The WAC administers funding from New York City Council (NYCC) to maintain high water quality. The WAC is made up mainly of farmers and foresters - 92% of the landmass owners have joined up. 69% of the Catskills is in private ownership, 14% owned by New York City Council and 17% is New York State owned.

The WAC has to maintain a minimum membership of 85% of the land within the watershed to avoid the New York City Council's draconian environmental laws.

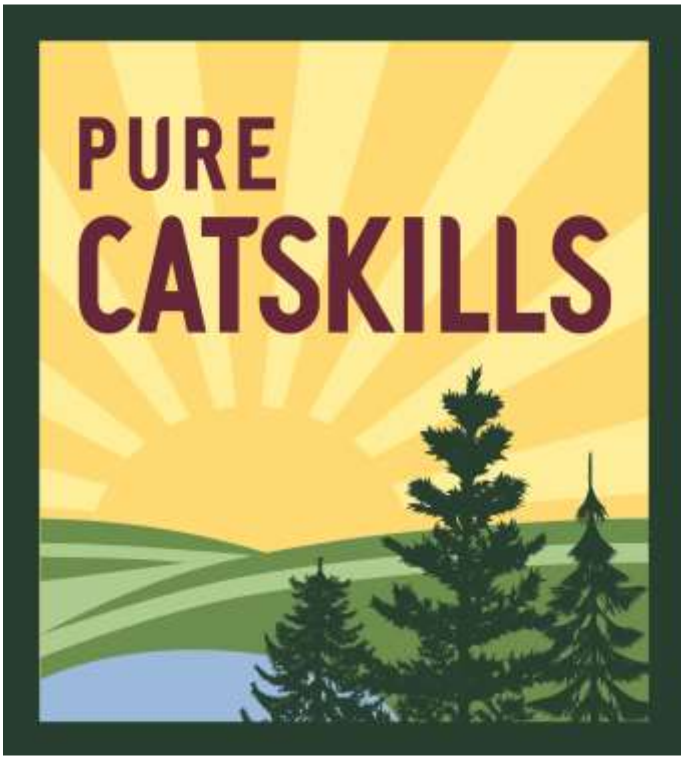
Whilst this is a voluntary agreement, there is a reasonable amount of pressure to sign up in order to avoid NYCC environmental legislation, which could be very restrictive on what can take place in the catchment area, and would seriously devalue the land. Historically the council has been very heavy-handed with their administration of the water supply regulations and their infrastructure development. This has been avoided with the formation of the agreement.

The protection of the water is carried out using nutrient management plans and assessments of potential groundwater polluting activities. Ideas from this have been: covering cattle yards, fencing off waterways from livestock, and making better use of water troughs.

The cost to New York City Council to help administer and support this fund to maintain their water quality is only a small percentage of the perceived costs of putting all the water through treatment plants before it is delivered to the city residents.

Figure 9: Youngstock accommodation partially funded by the WAC to prevent run off and rainwater contamination from what was previously an open yard

The WAC also sponsors a branding campaign called *Pure Catskills.* This is a campaign to market local, fresh products grown and reared and manufactured in the Catskills region. The brand highlights the conservation value of these products based upon the region's natural resources: pure water, rich valleys and grassy mountains, that sustain a diverse agricultural landscape. (*See poster below*).



8. Manure management

A major issue that cropped up time and time again during my travels was the movement of manure away from the large dairies. Slurry and solid manure was being trucked away in vast quantities to off-lying land. On more than one occasion I followed a muck truck through a country town heading to arable land and off-lying land away from the dairy. I cannot believe that it was particularly good practice from a timing point of view or from a public relations angle. This was going to sit on or in maize stubble from autumn until the following spring, by which time most of the nutrient value will have been lost. The ground was wet with slush and very cold; slurry application was either surface spreading or injection, with both tanker and umbilical systems being used. Considerable soil compaction and soil structure issues were evident.

In the USA large dairies and feedlots (over 750 head of adult stock) are governed by The Concentrated Animal Feed Organisation (CAFO) regulations. A major part of this regulation requires a manure management plan. I was not convinced as to how well, on some sites, this would stand up to close scrutiny.

Massey University in New Zealand is undertaking trials to measure runoff from land designated for slurry application on farms. Slurry can, in some areas, only be spread on a small portion of a farm. With the increasing use of housing for dairy herds this has increased the amount of collected manure. While in some cases there is enough allocated land for this to be spread, some farms do not have enough area, which can lead to over-application. Manure management plans, as practised in the UK, are used to ensure responsible manure use; they should be designed as a guide to best practice for a particular time of year and particular soil and typography. With the current decrease in milk price many of these housed cattle will probably return to grazing, and the shortage of designated land to spread on may not be an issue.

Figure 10: Prof. Michael Hedley of Massey University, NZ, outside the University's new dairy building

I met with Dr Victor Cabrera, Assistant Professor of Dairy Management at Wisconsin University. One of Dr Cabrera's roles is to work with farmers as an extension officer; benchmarking, monitoring and measuring pollution. Along with the United States Department of Agriculture (USDA) and the Environmental Protection Agency (EPA) they have dug wells on farms to measure nitrogen, potash and phosphates plus ground water contamination. The construction costs are billed to the land owners.

Nitrogen overloading is dealt with by barring any nitrogen, organic or inorganic, immediately, until the USDA and the EPA were happy with the levels. This was usually after the harvest of the following crop, or the end of the following growing season. This nitrogen level was not perceived as a major issue because of its relative simplicity to rectify. **See Appendix 2: The Nitrogen Cycle.**

More worryingly, the high potash and phosphate issues (above 6 on the UK scale) had in one area led to a 5-year ban on all P and K applications regardless of whether they were organic or inorganic. **See Appendix 1: Potassium and Phosphorus.** This has resulted in manure being trucked up to 20 miles away to find land able to take it. It also meant that no manure could be spread at any time during the growing season: only inorganic nitrogen. There was no advantage for the farms in this restricted area to use slurry or solid manure to fill all or part of their fertiliser requirement; it was cost all the way.

Another major concern is that traces of antibiotics and oestrogen were also picked up in the ground water. Whilst these had not been traced back to a particular farm, and there was no work being done at the time to look for any other sources of these pollutants, I am sure given time this will be looked into.

Similarly, an Amish community in Illinois had stopped using ground water because of the contaminants within it. It must also be noted that the normal ground water level was very high for a considerable period of the year and over a very large area; a lot longer in terms of time, and involving a larger area than would be naturally found in the south west of England.

This whole groundwater situation was causing angst among the locals, bad press for the farming community and resistance towards the government agencies involved in policing it. This was also creating difficulty where farmers were applying for planning permissions to expand their dairy and feedlot facilities.

There was little communication between any of the parties involved and not much progress was being made to rectify the situation other than employing legislation. There was a massive opportunity for the farmers or representative organisations to take charge of the situation and lead from the front, but there was very little evidence of this taking place.

I met Clay Reece, the herd specialist for Milksource. Milksource currently milks 32000 head. We met at their Rosendale Dairy. This particular site was home to 8000 milking cows.

Milksource currently has 10 miles of underground slurry mains that they either hook up to a tanker or umbilical cord, both of which can be used with an injector or surface spreading system, or to fill off-site lagoons. This enabled them to move slurry to the cropping land and to contract croppers. Slurry was applied according to crop requirements.

Figure 11: Clay Reece outside Milksource's Rosendale Dairy

To keep local residents onside, especially if manure removal involved trucks going through the centres of towns "Compost-Free Days" are organised. Separated solids are made available for anyone in the vicinity to load onto a trailer for use in their gardens, parks etc.

Milk was sold up to a year in advance and all financial targets were set as a margin per litre[2]. This enabled them to set a price for purchased feed. On the basis they know the other costs associated with running the dairy, their unknown cost is purchased feed. This gives them an upper limit to the price at which they can afford to purchase feed if they are to maintain their margin per litre.

Even with such a large number of cows to feed, most contracts Milksource had with growers were for only one year at a time. Some were for three years but these were few and far between.

Milksource commented that negotiation with cropping farmers was not particularly hard at the moment as corn (maize) and wheat prices were relatively low. Whilst they were aware the price may rise in the future, there were plans in place to source feed one or two years in advance, in a similar way to their milk sales. This will give current and future investors more long term comfort and aid budgeting.

[2] Whilst milk is bought and sold in the US per 100 lbs milk solids, the machinery milking the cows measures the **litres** produced. This figure is readily available to the staff, so is used to enthuse a culture of profitable milk production.

9. Cattle in an arable rotation

I am currently out-wintering cattle on our arable ground at home as part of our rotation. However, as the herd grows I will be looking to add extra overwintering facilities either from land at home, or third party land or housing. I have seen an excellent example of housed cattle forming part of the arable rotation.

Figure 12: Heifers out-wintering on stubble fodder crops on the Mendip Hills

Hoop Beef's slogan is: "*Bringing Cattle Back to the Midwest*".

Their aim is to place their buildings and cattle onto arable (mainly soya and maize) farms. The cattle are housed full time in a totally self-contained unit. Hoop Beef provides all the nutritional and veterinary advice. The animals are bedded on maize stalks and fed hay and ground maize corn provided by the host farm. The cattle then provide manure for putting back onto the arable ground.

The Hoop Beef System was founded by Dr Robert Bryan and sales are managed by Tim Bickett. They are based at Grand Meadow Feeders, in the USA's Midwest. Hoop Beef provide the buildings and the cattle. In this case they were incalf Jersey Gelvich heifers sourced as calves from dairy farms.

Whilst there is little or no relationship between a dairy farm and an arable enterprise in the UK there are plenty of lessons to be learnt.

Firstly, this design of building could arguably be put up without planning permission, as it is a temporary structure, comes in kit form, simple to erect and low maintenance. Most of the ones I saw, however, had been in place for several years and one had been in place for 20 years. It was designed to need minimum management and time spent looking after the livestock. The buildings are light and airy and adaptable, easily housing beef, dairy heifers or dry dairy cattle.

Figure 13: Cattle in the Hoop Beef System at Grand Meadow Feeders

Figure 14: Another view of Cattle in the Hoop Beef System at Grand Meadow Feeders

Secondly, this facility was providing manure to the corn farmers. Land that continually grows corn will be depleted both nutritionally and structurally.

It is important to note here that soil organic matter in the Midwest has decreased by up to 50% since the early 1900s.**See Appendix 3: Soil organic matter.** Phosphate and potash levels also decreased but, with the introduction of modern fertilisers, the levels have now been lifted to crop requirements. Whilst the decline in soil organic matter has been halted by using minimal tillage, retaining crop residues on the surface and fertiliser application, the organic content is not increasing back to its original levels of 2-3% on sandy soils and 8-10% on the heavier, more productive soils. However, by covering the land with manure from the Hoop Beef system both these problems are being rectified.

Grand Meadows have seen a combined benefit of $55/ha by removal of the corn straw for bedding, where it requires no soil nitrogen to break down the straw over the winter period. Nitrogen that would have been used up for the breakdown process if straw had been left in the field is now there for the following crop. This, plus the accurate application of manure from the cattle buildings using weigh cells and GPS, has really demonstrated the value of this arrangement made between cattle and arable farmers.

Whilst $55/ha doesn't sound a huge amount, when applied to the over-1600 ha Grand Meadows were cropping, the value added up to $88000 per year. Application costs including machine maintenance were costed at $25000 per year, leaving a net benefit of $63000 per year.

This type of system would easily fit into an arable operation in the UK and would provide a good opportunity for the dairy farmer to have his heifers or dry cattle reared offsite, releasing grazing or housing for added dairy cattle. Whilst the issue of bovine TB will make such a system complicated in the UK, particularly in the south west, I think that an 'all in, all out' system, with stock leaving and returning to the same dairy farm, would be a workable solution, with the host farm only rearing cattle from one supplier livestock farm. This will prevent the spread of disease between livestock farms. Other biosecurity measures would be worth considering.

10. Composting

10.a. The Angle Dairy, Moxey Farms, Goolagong, north of Sydney.

Moxey Farms have a housed dairy with crops grown and ensiled for their livestock.

Manure is held in lagoons and separated. The liquid travels through an open canal system which enables application by irrigation and pipeline whilst solids are separated and composted. This compost consists of not only separated cow manure but also used bedding from the calf housing. Some baled straw from the arable enterprise that is not used for bedding or feed is also used to help the composting process.

Deadstock is also composted. Whilst this inclusion of cadavers would not be possible in the UK the compost is a valuable source of nutrition and organic matter on some very light sandy soils.

It is felt that the composting is so important to aid soil condition and plant health it is continually monitored and worked by turning and adding water, where necessary, to provide the best possible soil conditioner and be incorporated when cultivating.

It would certainly be possible to take solids from a dairy and compost it. In the interests of using as little transport as possible it would be best to set some space aside at point of production and then move the final compost product off site. Other sources of compost could also be added if available but in the UK there are strict rules defining what can and cannot be brought onto site to compost. A different set of regulations sets out the rules for spreading compost that originates from different sites. This is a separate topic all together.

The composting process does destroy any arable residues and weed seeds and should, if done well, provide a friable and easily spreadable product.

Figure 15: Moxey Farm's composting yard

11. Technology being developed to reduce inputs and maintain productivity

Some interesting developments in the arable sector, using GPS and Infrared technologies, are being trialled for use on dairy and livestock farms.

11.a. Green sensing

I visited the Bernie Campus at the University of Tasmania. This campus is home to the Cuthbertson Research Laboratories managed by the Institute of Agricultural Research. This is where Dr Richard Rawnsley and Dr James Hills have taken the technology that is currently being used in arable farming for sensing green growth on arable stubbles, and are looking at using it for other applications.

Figure 16: Green sensing equipment in stubbles (taken in the evening for visual impact)

This technology is currently used to detect green growth in arable stubbles so that a blanket spray of glyphosate is avoided, and only the green - either weed or previous crop regrowth - is sprayed to kill it off. The savings depend on the density of green growth over a particular area but the resultant kill is 100%. The less green there is to spray off, the less spray needs to be used to leave completely clean stubble for the next crops to be planted. This has led to savings of up to 90% in the use of glyphosate. This also saves on downtime for refilling the spraying machinery. The machine does however still need to cover the whole of the area to be sprayed.

11.b. Liquid fertiliser application

Drs Rawnsley and Hills have developed this technology used in broad acre arable farming and altered the areas of light reflection readings to differentiate on a more or less green variation for applications on grassland. This has enabled them to produce a liquid fertiliser applicator that is selective about the area where it applies a product - it will not apply fertiliser to patches of ground that cows have urinated on and soured. This machine is in its very early stage of trials and has only been tested with nitrogen; but so far savings of up to 40% have been seen with no decrease in grass growth. This machine has the potential in heavily grazed situations to save a considerable amount of fertiliser and also some operational time with fewer fill ups required to cover the ground.

Figure 17: Mounted variable rate liquid fertiliser applicator

If, over a whole farm, over a whole growing season, 20% less purchased fertiliser was used, savings could be substantial.

A farm of 100 ha using 250kg/ha of 34%N costing £230/t uses 25 t. If 20% (5t) less is used the saving is £1150.00.

The benefits of this machine will be increased as the grazing season progresses when more and more urine patches will become evident.

This same type of technology will also be trialled to spot spray weeds in grassland by using sensors which can pick up the different types of green (i.e. grass v dock) resulting in minimal herbicide use. The savings could be similar to savings using green sensors on wheat stubbles and should encourage more frequent and better targeted spray applications whilst using a fraction of the active ingredients.

Figure 18: Arial picture of my farm showing dark urine patches in between the grazing cows in right hand foreground

11.c. GPS guidance

Precision agriculture equipment can also be used to plant specific crops in particular parts of a field. GPS technology is being used to plant the new crop between the rows of the harvested crop. I saw this being used in some of the dry parts of Australia, particularly in New South Wales, to help preserve moisture and provide some protection to the new seedlings from wind and wind blown sand, and also offering some shade.

When precision agriculture is combined with direct drilling there can be a reduction in rotation time through the benefits of disease control. Some soil-borne diseases, such as club root, can only survive around the root zone. The area around a root is not disturbed when direct drilling is practised and the new seed is placed in the clean soil between the previous crop's rows. When continuous direct drilling is used this will, in effect, fallow the ground between crops.

Figure 19: GPS guided seed drill

This type of GPS drilling can also be used to plant the deep rooted red clover into longer term grassland than has previously been practical. Red clover only lasts for 2-3 years whereas a good ley can be productive for 5 years or more if carefully managed. GPS drilling practices could drill the land accurately enough to allow continuous clover in a long term ley, and allow enough time between cropping to alleviate disease pressures through rotation shortening.

If red clover is planted in widely spaced rows in the field in year 1, and then in year 3 more was planted in between these rows, the red clover would then last the full term of the new ley. Where red clover is to be grown in permanent pasture it would be possible to drill in year 1, year 3 and year 5, and then, in year 7, return to the planted area used in year 1.

A typical ryegrass ley has a protein content of 15.6% but a ryegrass and red clover mix has 18.8% protein. There is also some evidence that the dry matter content can be higher in the mixed sward silage, but that really is dependent in how the silage is made and the conditions it is made in.

A mixed ryegrass and red clover sward is more suited to silaging than grazing, especially in the spring when the ground can be wetter, but after two or three cuts of silage the ground can be grazed successfully.

There is little requirement for nitrogen in a clover/ryegrass sward but there is a requirement of 125kg phosphate and 275kg potash on land with soil indexes of 2 . This could easily be supplied by slurry in the spring and between silage cuts. Excessive slurry will, however, damage clover and this is where guidance technology can play a part, by using an injector or dribble bar between the rows of clover.

This method is being used for growing vegetable crops in Holland, with application rates set for the different crop requirements and row width settings.

Figure 20: Precision slurry application

It may be necessary in the future to look at how low ground pressure equipment or umbilical machinery can be used for accurate placement of slurry; but umbilical systems tend to smear the slurry over the sward as the pipe is trailed around the field; this contaminates the grass crop and will, if the field is intended for grazing, mean a longer time period between grazings.

Large savings can be made from using less purchased fertiliser, aiding cash flow, but the manure still has to be spread. Using an injector tanker may be more expensive than using standard slurry tankers or an umbilical system, but the manure will be available to the growing crop straight away.

12. Discussion and observations

Farmers need to be proactive in monitoring activities on their farms, should be open to scrutiny, and willing to tell the story of their food production to the customers on their doorstep. We have a huge concentration of buyers on this island and it is important that we keep them on our side, that they understand our methods of farming and how we care for the livestock and the environment. This is only possible if we can produce our products with profit, and working together and monitoring our inputs and outputs will help reduce costs and reduce the goods bought into the dairy farm.

Figure 21: My membership of the Borlaug Farmers Association of South Asia

Most farmers, the world over, want to do their own thing and the wealthier they become the more independent they become, until a point where partnerships become a necessity to move the business forward. However, even in the less well-off parts of the world such as India, there are organisations, such as Borlaug Farmers Association of South Asia which, along with industry leaders and government advisors, has a membership of over 3 million farmers. This association passes information on to farmers and local coordinators to help the husbandry and marketing of various crops, particularly maize, wheat and rice. Most of this information dissemination is through on farm meetings.

There are clearly benefits from two parties collaborating but this involves trust and goodwill from both sides. This is easy to measure when the results are purely financial but less so when we look into soil nutrition and thus try to determine the financial gain from potential inputs.

Measurements must be taken to ensure an accurate starting point and a defined finishing line. It is important to know the mineral values of the applied products to determine not only how much is needed but the financial value. There is no point in over-applying purchased goods. Likewise it is also important to know the application costs. We need to remember that financial gain is, for these purposes, measured in increased income and decreased expenditure.

There is some technology that can be taken from the arable sector and used in the dairy and livestock sectors, both in the housed and grazing situations. This technology will become more available and usable and, with increasing use of GPS type engineering, it will no doubt be the machinery belonging to contractors and large scale farmers; but it will be able to play a part in delivering returns to the small scale farmer, through the use of either contractors or equipment sharing.

There are some individuals and organisations that are particularly difficult to work with. These situations must be identified and walked away from sooner rather than later. There is little if any point, on either party's behalf, of having a miserable relationship. Less effort will be put in to make it work and it is inevitable that one party will feel aggrieved, both mentally and financially

Below is an extract from an EU consultation paper: "The policy implementation of nutrient management legislation and effects in some European Countries"

Christine Jakobsson[1], Ellis B. Sommer[2], Patricia De Clercq[3], Giuseppe Bonazzi[4], Jaap Schröder[5]
A presentation held on 18th April 2002 in Gent, Belgium at the final Workshop of the EU concerted action Nutrient Management Legislation in European Countries NUMALEC

> *"One important source of nutrient pollution is agriculture. The loss of nutrients, such as nitrogen and phosphorus, can initiate from point sources such as barns, manure stores and milk rooms, and can relatively easily be taken care of in a suitable manner. Loss of nutrients from the management of fields and crops is diffuse pollution and is much more difficult to curb with effective measures. Loss of nutrients leads to eutrophication of water-courses and the sea, as well as to acidification of land areas and to reductions in biological diversity. To reduce the negative effects of agriculture, legislation and policy have developed in all EU countries." (www.siteresources.worldbank.org/INTAPCFORUM).*

I believe that it is important that we, as farmers in both the dairy and arable sectors, take heed of the statement above and lead the way in developing systems that not only reduce our reliance on purchased inorganic inputs for crop nutrition, including grass, but take the best advantage of nutrition provided by the livestock and use it in a timely and responsible manner.

It is our responsibility to lead the way in developing not only good relationships between farmers, environmentalists and legislative officials to aid this, but also to embrace technology to lead the law makers so that we do not end up with areas of land with overbearing rules and regulations that are difficult or near impossible to implement. It is crucial that we end up with good implementable practice that is developed at farm level and not imposed from above.

Industry led innovation before we get government forced regulation!

13. Conclusion and Recommendations

1. There needs to be a certain mind set to create a combined or collaborative system of work. All parties involved must see a positive outcome. All parties must want to make this work.
2. Clear lines of responsibility must be drawn up which allow each individual or organisation space to make their part work. This needs regular review to ensure targets are being met, issues aired and corrected at the soonest opportunity.
3. I believe the current milk price and the volatility of the milk market will increase the need for more cooperation between different operators, particularly on the larger dairy units. This cooperation will help sell the large dairy image to the public particularly when they see the waste from one enterprise feeding the growth of the arable crops and the reduction of inorganic products used.
4. To make the best use of animal waste onto arable farms, housing stock on these farms could well be the cheapest method. We will need to get on top of the current TB crisis before farmers become confident about moving animals to and from different sites.
5. Use of technology initially designed for the arable industry is being adapted for the dairy and livestock farms. The correct use will reduce the chemical requirement for grass production for both grazing and housed cattle.
6. It is important that bulky waste materials are not transported unnecessarily; this is expensive and time consuming. These products need to be moved once to their point of use: we do not want to add to transport costs. Timing is critical so the expensive transport costs can be mitigated by making the most of the slurries and manures applied.
7. We have a responsibility as our farms grow to ensure we are open to public scrutiny and not hiding what we are doing. The public are our customers, we should not forget that. Many food producing countries do not have the density of people we have here in the UK; they are envious of our close-at-hand large customer base. We need to promote our products and practices to ensure UK agriculture has maximum exposure to our own home market.
8. We have a duty to ourselves as an industry to make sure we are confident that we operate in an environmentally safe manner. If we see or even perceive there to be a problem it should be our duty to rectify the problem before more government regulation is forced upon the industry.
9. Best practice will continue to change and improve and we as an industry need to be one step ahead of the regulators to get it trialled and employed so we can see the benefits without the red tape. Red tape does little good to the environment, farmer, enforcement officer or profit.

After all one willing volunteer is worth ten pressed men.

14. After my study tour

We have been using injected slurry on our own grazing and silage ground this year. Average UK grass growth rates in July were 70kg DM/ha: we were running at 60kgDM/ha.

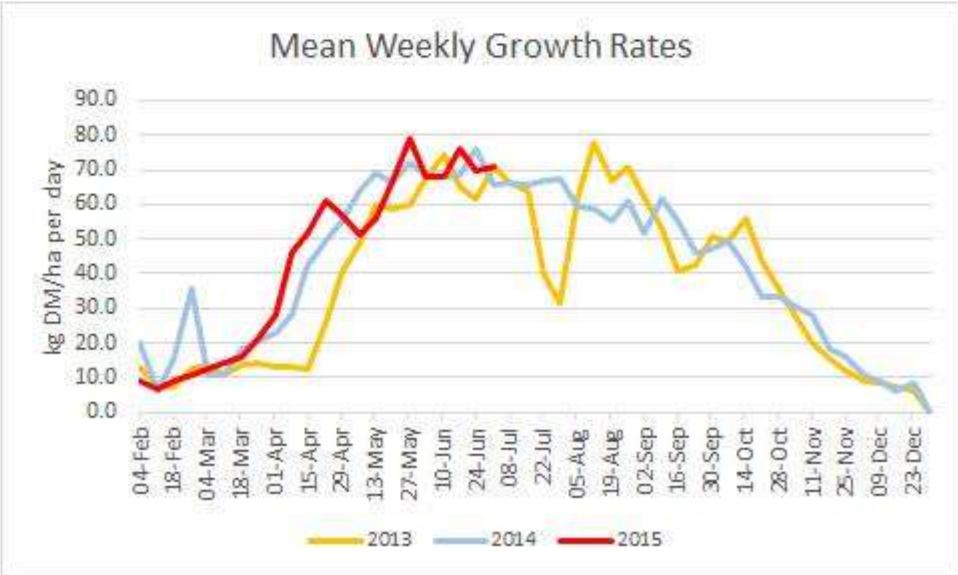


Figure22: Average grass growth rates across the UK in terms of kilograms of dry matter per hectare
Source: Mary McEvoy

The only purchased fertiliser we applied was in March. This was applied at a rate of 125kg/ha of 34% nitrogen. No allowance is taken for rainfall and soil conditions but grass growth has been consistent and of a good quality. Growth is measured weekly with a plate meter.

After fields are grazed, slurry is injected shortly afterwards, ideally within 3 days. This injection not only adds nutrition but acts as a source of moisture in dry spells. This practice has worked particularly well in our grazing system this year, especially through the summer when we had little rain. Where the land is close at hand, at application rates of 20,000 litre/ha, 6ha covered/hour is achievable. The weight of the machinery could cause soil compaction issues if used when the ground is wet. It is particularly important for the injected slurry to fill the channel cut by the machine's injector disc but not overflow as any overspill will contaminate the grass, making it less palatable for the cows during their next grazing. When this is all done correctly there is no need to wait for rain to wash the plant before the next grazing. Through use of this technology our rotation for grazing has been reduced to typically 2 weeks.

As mentioned above this grazing season has been dry and able to easily handle the heavy machine; but there will come a time when it is not possible to use this and a low ground pressure or smaller light weight machine will have to be employed.

Figure 23: Applying slurry on our grazing ground in summer 2015 using an injector tanker

An unforeseen advantage of using this injector tanker is that, as the machine moves over the ground, the discs help to break up the cow pats left behind from the previous grazing. This speeds up their decomposition and nutrient release.

I will be using a GPS-guided drill to add red clover to some of our permanent and temporary grassland in 2016.

We will continue to offer an open door policy to allow public, industry and officials to see what we are doing on our farm.

"…. whoever could make two ears of corn, or two blades of grass, to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together." *(Swift: Gulliver – Voyage to Brobdingnag)*

15. Executive summary

In 2010 we built a new milking facility. To make the best use of this expensive milking machinery more cows were added to the system, requiring more feed to be imported onto the farm, resulting in more waste being applied to a relatively small area. This, combined with cheesemaking waste also spread over the same land will , if we are not careful, result in an overload of nutrition, and at some times in the year create soil condition problems.

The aims of the study are:

- To see if there are any contracts or operating procedures where the costs of the material imported onto the farm could be offset by value of the waste products produced.
- Could these be exported to nutrient-deficit sites off farm?
- To reduce the amount of inorganic minerals bought onto the site.
- To understand what restrictions and help have been placed on farmers by government departments that could be adopted or situations that need to be avoided.

On my main study topic tours I visited the USA, Australia, New Zealand, Ireland and Poland, as well as sites in the UK. I chose these countries for their varied dairying styles and arable enterprises to see if there were relationships between the two types of farming that could be developed and incorporated into our systems in south west England. As an aside to my main study topic tours I undertook a Nuffield Australia Global Focus Tour of Australia, India, Qatar, Turkey, France, The Netherlands and USA. Whilst this was not part of my study tour some reference may be made to these places in my report.

There are very few formal agreements operating between farms that cover more than a particular growing season, and they mostly all rely on the goodwill of both parties and financial viability of each operation. There is one contract that may be possible to introduce into the UK from the USA involving a contract with a broker, meaning that the buyer and seller are not at the mercy of each other's financial situation and their personal preferences.

Clearly there are also values to the manure from the dairy herd. This needs management in the form of storage and application to realise the best onsite and offsite value to the land. Other parties contributing to the feed imported to the dairy farm could also benefit from this organic nutrition. The correct use of nutrients will offset purchased inputs. Considerate management will reduce the impact large dairies are perceived to have on the environment.

Johnny Alvis

16. Acknowledgements

I am very grateful to the Nuffield Farming Scholarship Trust for awarding me a Scholarship and for the sponsorship from The Trehane Trust and the Dartington Cattle Breeding Trust. Thank you all for having faith in me and my study topic.

I would also like to thank the Mercer Family for helping me join the India Global Focus Programme (organised by Nuffield Australia) giving me the opportunity to visit places and meet people I would not have seen otherwise.

Huge thanks must go to my wife, Jo, and our three children, Victoria, Katy and J, my parents and brother and my work colleagues who have all enthusiastically supported my time away from home, the farm and our business, and have run the farm well in my absence. None of this would have been possible without their help and encouragement.

To Jane Bennett, Rick Wylie, Andrew and Tracie Heinrich, and Craig and Roz Mackenzie who have all let me invade their houses on several occasions – thank you.

Thank you to all the people who have put me up for the night and spared their time to make this a truly memorable year.

Over the page I have listed, in country order, these wonderful people who helped me so much.

Finally thank you to, in no particular order: Jamie McCoy, Karen Brock, Emma Germano, Lucy Griffith, Joe Leonard, Ben Ralston, John Murphy, Tim Gubbins and Paul Niven, for being the best companions to travel around the world with.

17. My Nuffield Farming study tour itinerary

Thank you to all the people mentioned below who have given me their time.

AUSTRALIA March and May 2014

Mar 11 2014	Post CSC 5 day tour of New South Wales, Australia
Mar 16 2014	Fly to Launceston, Tasmania.
Mar 17 2014	Greg Gibson, Arable and Sheep
	Rob Nichols, Poultry - broilers and processing and Arable
Mar 18 2014	Simon Bennett, Dairy grazing
	Chris Dornauf, Robotic Rotary Dairy
	Nigel Brock, Dairy
Mar 19 2014	Paul Niven, VDL dairy
Mar 20 2014	Richard Rawnsley, Tasmanian Institute of Agriculture, Burnie, Tas.
Mar 21 2014	Paul Bennett, Dairy
	Karen Brock, Horticulture and Tissue Culture

Pre Global Focus Programme

May 23 2014	John Gladigau, Arable Collaboration
May 24 2014	Lochlan and Dennis Smart, Sheep, Arable and Adversity
May 25 2014	Andrew Heinrich, Contract Arable
May 26 2014	Andrew Heinrich, Kangaroo Island, Merino and White Suffolk Stud
	Caleb Pratt, Sheep and Arable
May 27 2014	Sam Mumford, Feed lot Aberdeen Angus x Simmental Beef

Poland August 2014

Aug 22 2014	Lucjan Grzegorczyk, Spearhead Farming, Leka and Golebin Farms, Poznan, Dairy and Arable

IRELAND September 2014

Global Dairy Farmers Tour

Sept 23 2014	Joe Leonard, Dairy Collaboration of Family and Neighbours, Golf Course
Sept 25 2014	David Murphy, Lismore and Moore Hill Dairies
Sept 26 2014	Bill O'Keefe, Dairy
Sept 27 2014	Glambia, Greenfields Dairy Programme
Sept 28 2014	Mary Delaney, Dairy
Sept 29 2014	Galway Oysters
Sept 28 2014	Joe Leonard

USA October/November 2014

Oct 30 2014	Dr Victor Cabrera, Wisconsin University
Oct 31 2014	Clay Reese, Milk Source, Rosendale Dairies, Wisconsin
Nov 3 2014	Darin Strauss, Majestic Crossing Dairy, WI
Nov 4 2014	Prof Brian Gould, Wisconsin University
Nov 5 2014	Andy Hatch, Uplands Dairy, Milking and Cheese Production
Nov 7 2014	Tim Bickett, Hoop Beef, Iowa
	Nial O'Boyle, Black Sands Dairy, Iowa
Nov 11 2014	Merle Kaufman, Dairy Goats, Cheese and Yogurt
Nov 13 2014	Doyle Waybrick, Mason Dixon Farms, Pennsylvania
Nov 15 2014	Skip and Holly Hardie, Dairy, NY
Nov 17 2014	Kirsten Torgersen, Gavin Gates, Cornell University Graduates
	Bill Morgan, Dairy and Cayuga Dairy Processing

New Zealand January 2015

South Island

Jan 2 2015	Craig and Roz MacKenzie, Precision Ag, Seed Production, Arable and Dairy
Jan 9 2015	Ron Pellow and Dawn Dalley, Lincoln University,
Jan 10 2015	James, Housed Dairy
Jan 12 2015	Mike Trubshaw, Multisite Dairy
	Jeff Gould, Housed Dairy
Jan 13 2015	John Murphy, Vines and Garlic

North Island

Jan 15 2015	Roger and Barbie Barton, Sheep
Jan 19 2015	Martin Nelson, Goat Farming
Jan 20 2015	Ben Troughton, Dairy Farm Advisor
	Doug Bull, Dairy Advisor
Jan 21 2015	David and Nicky Hurst, Multisite Dairy
Jan 22 2015	Craig Hurst, Multisite Dairy, NZ Young Dairy Farmer
	Mel Poulton, Sheep and Beef
Jan 23 2015	Prof Peter Kemp, Massey University
	Prof Mike Hedley, Massey University
	Lucy Griffith

Australia January 2015

Jan 27 2015	Steven Creese, Dairy and Cropping
Jan 28 2015	Jane Bennett, VDL, Housed Dairy, Tas
Jan 31 2015	John Moxey, Moxey Farms, NSW
	C and E Thompson, Silvermore Holsteins, Housed Dairy

12. Appendix 1: Potassium and Phosphorus

As with phosphorus, large volumes of potassium are removed at harvest. Potassium losses from the field decrease as the clay content increases in the soil. Often sandy and soils with very high organic matter are low in potassium and are prone to have any that is present leached out. It is not easy to build up reserves of potassium in these soils so it requires topping up annually.

Typical levels of Nutrients in FYM and slurry *(British Grassland Society)*

	Dry Matter	Nitrogen	Phosphate	Potash	Available P	Available K
Cattle FYM	25%	6Kg/t	3.5kg/t	8.0kg/t	2.1 Kg/t	7.2Kg/t
Dairy Slurry	6%	3Kg/m	1.2Kg/m	3.5Kg/m	0.6Kg/m	3.15Kg/m

Potash and Phosphate requirements (Kg/ha) *(British Grassland Society)*

Phosphate index	0	1	2	3
Grazed Grass	60	40	20	0
Silage Grass 1st Cut	90	65	40	20
2nd Cut	25	25	25	20
3rd Cut	15	15	15	0

Potash Index	0	1	2	3
Grazed Grass	60	30	0	0
Silage Grass 1st Cut	140	110	70	30
2nd cut	120	100	70	40
3rd cut	80	80	60	20

See Appendix 2 on next page

13. Appendix 2 : Nitrogen in manure

Optimum nitrogen use is at times of maximum crop uptake – late winter or early spring. Nitrogen is lost through nitrate leaching of ammonium volatilisation into the atmosphere. This can be avoided by incorporation into the soil either through tillage or direct injection.

My preferred method on grassland is by direct injection, using a shallow disc injector so as not to spoil the sward, bring stones to the surface or loosen the ground to make grazing difficult, particularly in wetter conditions. Low dry matter slurry is quickly infiltrated into the soil and reduces the nitrogen lost to the atmosphere.

The recommended application rate is 250kgN/ha/year.

Farm yard manure of 25% dry matter equates to 42t/ha

Cattle slurry of 6% dry matter equates to 83m³/ha

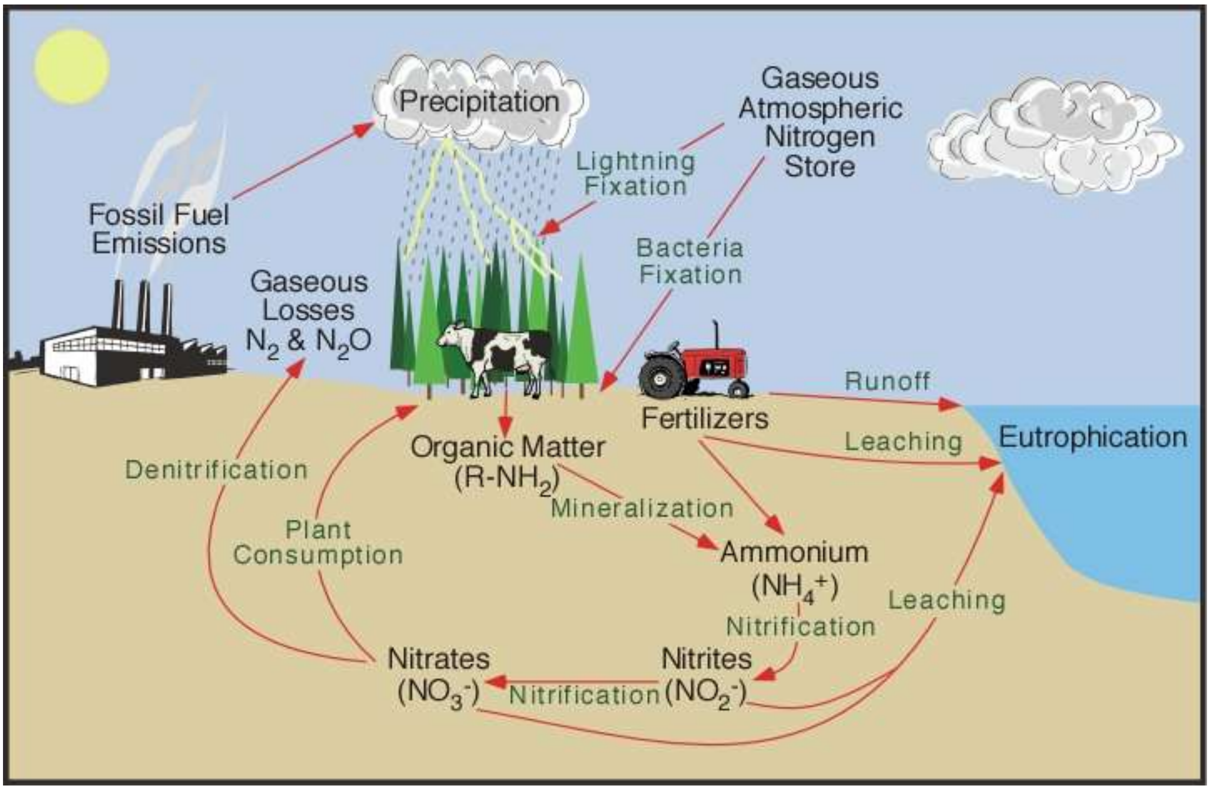


Figure23: The Nitrogen Cycle (www.physicalgeography.net)

14. Appendix 3 : Soil organic matter

Organic matter in soils will usually be around 5%. This level is critical for the health of the soil.

Increasing organic matter in the soil helps to improve soil structure. It increases the water retaining capacity of the soil land, increases the ability of the soil to retain nutrients and ensures that these nutrients can be available to the growing plants.

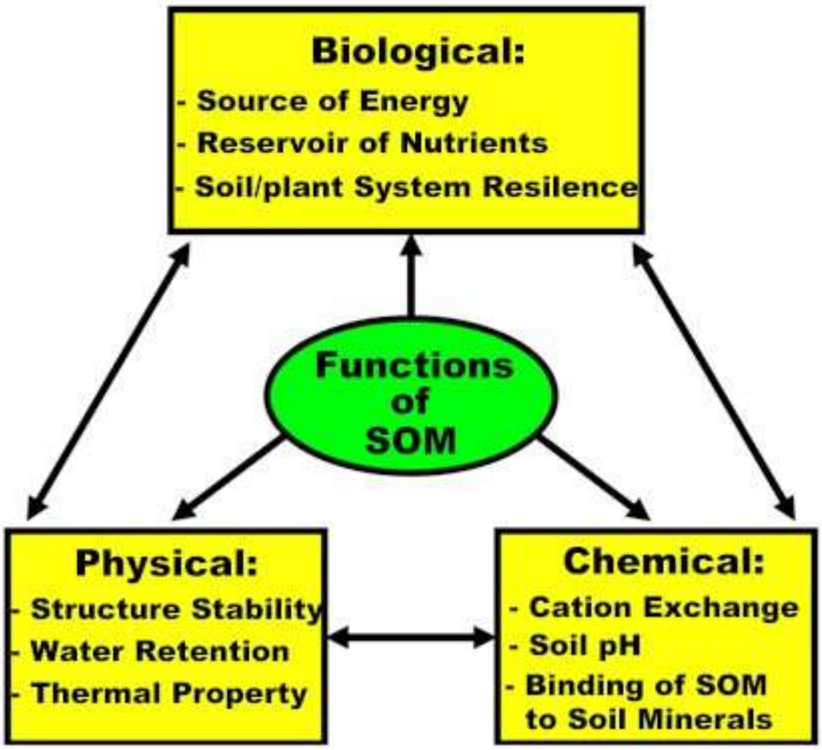


Figure 24: Nitrogen cycle