Better utilisation of phosphate is something which is paramount to the future of agriculture as we know it in the UK. Phosphate is vital for plant growth and for sustaining the yields that are vital for feeding the planet. However, we are running out of inorganic phosphate – there is 80-130 years left and none of the deposits are situated in the EU! This is currently reflected in the sky-high price of inorganic phosphate, Triple Super Phosphate (TSP) is currently trading at £700/tonne and is expected to reach £760/tonne by January 2009.
Another major consideration is that phosphate is a serious environmental pollutant when it enters watercourses, in many cases being far more important than nitrate. The EU have introduced the Water Framework Directive that demands serious improvements in water quality throughout the UK.
The third major issue, especially on dairy farms is that some fields tend to have very high levels phosphate in the soil. These tend to be field which have historically had a lot of manure applied in the days when slurry was a waste to be got rid of rather than a valuable source of organic fertiliser. The trouble is that as P indices rise over 3 other plant nutrients are antagonised within the soil so that inherent soil fertility drops.

Our industry is facing difficult times in terms of phosphate…. Will it be Farmaggedon or will we find new and innovative ways to manage phosphorus on our dairy farms for the benefit of the whole agricultural industry?

This report is compiled totally of my own views and does not necessarily represent the views of the Nuffield Farming Scholarship Trust or those of any sponsoring body.

I would very much like to thank my main sponsor, the Oxford Farming Conference for their financial support as well as Growhow UK and Dairy UK both of which have also provided me with extra funding which allowed me to attend the International Phosphorus Workshop in Denmark.

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…centrate on dairy farms?

I decided to study this topic because of a Basis Soil & Water Management and a FACTS training course, both at Harper Adams while I was working as a farm conservation adviser for FWAG. On both courses I kept hearing that phosphate would be the next thing to be regulated, it potentially had a huge impact on businesses and nobody really knew how to tackle it.
This started me thinking that we really needed to know what the available solutions are before any new regulations are imposed on the industry to enable us to respond in the best and most cost effective way.

I started the study looking at the whole livestock industry but quite early on I decided to focus on the dairy sector. I felt that beef and sheep farmers had less of an issue with phosphate, and especially slurry. I chose dairy due to interest and also because it has a strong presence in my area of the country. The pig and poultry sectors also have big issues with phosphate and although this has begun to be tackled with the addition of phytase in diets, some of my recommendations will be equally applicable to the pig and, to a lesser extent, the poultry sectors.

oblem

Phosphate is a serious environmental pollutant and in many watercourses has a more important affect on eutrophication and effectively the fish death than nitrogen. The trouble is that whereas the loss of nitrogen is agronomically significant, the amounts of phosphate needed to cause pollution is tiny compared to the amounts applied. This means that whereas there is a strong economic case for preventing nitrogen leaching, the same is not true of phosphorus.

What is Eutrophication?

Eutrophication is nutrient enrichment of watercourses, nitrogen and phosphorus are the main culprits. Excess nutrient in the water leads to algal bloom which then covers the surface of the water, blocking out light which in turn can cause water plants to die off. The algae itself can present a real hazard to wildlife and people, in many cases blue-green algae take over which are highly toxic. The algae dies off which creates a huge food source for microbes within the water, the microbial population booms to take advantage of this new food source and they work hard to break it down. The microbes are suddenly taking a lot more oxygen out of the water for respiration as there are a lot more of them working harder, this means that water becomes oxygen deficient and water animals such as fish, insects and crustaceans are effectively drowned in the water as they are unable to extract enough oxygen to live.

Phosphate is more significant than nitrogen in eutrophication because it is usually the limiting nutrient. Many watercourses have a large excess of nitrate available for plant and algae uptake, however, no algal bloom occurs because there is insufficient phosphate to support it. The nitrate is a serious problem for water companies as it must be removed from drinking water, an operation that costs UK water companies (and all water consumers) millions of pounds per year in the UK. However, if we can reduce the level of phosphorus getting into watercourses then the eutrophication problem can be tackled.

HOW DOES PHOSPHATE GET INTO WATERCOURSES?

1. Soil Erosion

Phosphate is often adsorbed (chemically stuck) onto soil particles and any soil erosion or soil wash (brown water running off fields) will take phosphate with it. If the soil ends up in a watercourse so does the phosphate. Adsorbed phosphate does not immediately contribute to eutrophication as it is not bioavailable. As sediments settle out in river, stream and lake beds the phosphate it slowly released over decades. This release from sediments is a serious contributor to phosphorus in watercourses and means that even if we stopped all new phosphorus getting into watercourses there would be a eutrophication problem for at least 20 years as the bioavailable phosphate is released from existing sediments. Of course it is not just soil erosion from agricultural fields, natural bank erosion contributes hugely to the sediment (and phosphate) in watercourses.

2. Dissolved Phosphate

utrient pollution as water travels over the soil surface es into contact with in the form of orthophosphate which is bioavailable. This a particular problem in permanent pasture and long term leys where either inorganic or manure phosphate has been routinely applied. Phosphate does not move far down the soil profile of its own accord, in these long term grasslands the soil has not been cultivated so the top few millimetres has a super concentration of phosphate and this is easily dissolved into water passing over the soil surface.

This is also an issue where slurries are spread before rain. As discussed later in the report many herds are fed an excess of phosphate which leads to the excretion of bioavailable phosphate in the manure. If this is spread prior to rain then the bioavailable phosphate will be readily dissolved in the run-off or soil water and washed into watercourses where it will go on to cause eutrophication.

3. Leaching

In the past it has been thought that phosphate does not leach, however, at soil indices 4 and above small, but significant, quantities may be leached. This is seen especially in lighter soils (sand, loamy sand and sandy loam). Good research work has been carried out in Denmark which shows that applications of manure to light soils in Autumn causes significant leaching of both bioavailable phosphate and nitrate. It is also likely that this effect would be seen on heavier soil with significant macropores (eg. cracks) before heavy rain.

Global meat and milk production is expected to double by 2050 – this means that the environmental impacts of livestock farming must be halved just to maintain the status quo! (Dijkstra et al 2007)

sphate

The world is running out of inorganic phosphorus, it is estimated that there is between 80-130 years left (there are no deposits in the EU). This means that prices are only going one way as we have seen over the past 12 months with Triple Super Phosphate (TSP) rocketing to a current price of £700/tonne being by far the most expensive of the three main plant nutrients per kg of nutrient.

The Agronomic Problem with Phosphate

Phosphorus antagonises other elements. Phosphate indices can be very high in some fields on dairy farms. Historically manure has been thought of as a waste product and has tended to be applied in large volumes on handy fields close to the buildings leading to phosphate indices in many cases of 4+. This can lead to problems with other plant nutrients as the phosphorus ion antagonises uptake of other ions such as Fe and Zn. Clearly applying more phosphorus in the form of manure to fields with high P indices is not a good idea, but on many dairy farms across the UK is standard practice. Not only is it wasting the phosphorus, and literally throwing money down the drain, it is also creating deficiencies in other plant nutrients which will reduce the vigor and amount of growth. Bear in mind that every kg of phosphate is currently worth £1.49/kg (75p per unit) and that an average 1000 gallons of dairy slurry contains 5.4 units of available phosphate (10.8 total units) making the available phosphate in an application 2500gal/ac worth over £10 per acre.

It is totally unsustainable to be applying phosphate in any form to any land over and index 3 (unless growing potatoes) and a solution needed to be found to address the environmental, economic and agronomic issues.

Agriculture needs to clean up its act! The water framework directive (WFD) from Europe is "the most substantial piece of EC water legislation to date" (DEFRA). The UK government faces huge fines if we fail to reach stringent water quality targets which include almost all inland and coastal waters being in "good ecological and chemical condition" by 2015. This date is fast approaching and progress has been slow to date. I have it good authority that the government has no qualms about resorting to serious measures to meet them including pesticide and nutrient taxes.

The reality is that the polluter pays in today's world. The water companies currently spend millions of pounds cleaning up water for consumption and one day that bill may have to be at least partially carried by agriculture.

Studies have been carried out in the UK to assess the likelihood of reaching the WFD targets in time and a 2007 publication by Johnes et al in the British Society of Soil science concludes that "Generating good ecological status will require substantial changes in agricultural land use and management." They also suggest that "generating good ecological status is likely to require taking sensitive land out of production, introducing ceilings on fertiliser use and stocking densities and tight controls on agricultural practice in high risk areas." Control of N and P will be needed to generate good status is many watercourses. At the moment the only controls on manure application to fields is nitrogen based. In many cases this leads to over application of P and several other European countries are taking the approach of limiting manure use by P application and regulating the P that is produced on farms:

Denmark: There is a national action plan to reduce the P surplus on farms, this issue has been worked on since 1998 primarily by the Danish Agricultural Advisory Service. There are several phosphate sensitive areas around the country and in these areas, dairy farmers with over 75 cows need a license to expand the herd. To get this license, in some areas farmers must show a zero phosphate surplus, which I am told, is extremely tough.

Republic of Ireland: The interpretation of the nitrates directive the Republic of Ireland means that farmers must test soils before applying any inorganic P fertilizer. Farmers must carry out nutrient planning which also takes into account the nutrients imported on to the farm in fertilizers and animal feed.. The regulations on P in manures do not kick in until 2010 although this will have a big impact on the rate at which manure can be spread. Livestock farmers must complete manure plans to include where manure is to be spread on farms where manure is exported to – this has caused uproar among farmers and the plans need to be submitted to the Environmental Protection Agency so that have full records of which fields have had manure spread and when.

Sweden: Only 22kgs of P can be applied per application of organic manure in Sweden. This is equivalent to 18m^3/ha or 1650 gallons per acre of average dairy slurry or 6.2t/ha low rate of manure application which equates to f application recommended in the UK water code. In Sweden there is also a voluntary programme called Greppa naringen ócatch nutrientsô that is operating in an advisory capacity, in a broadly similar manner to the English ELS scheme, with an associated grant scheme looking at nutrient planning, catch crops and constructed wetlands. Uptake is variable through the country.

UK:

The UK government have decided not to introduce any phosphate regulation through the revision of the NVZ legislation, however the DWPA (Diffuse water pollution from Agriculture) legislation has the potential to regulate the use of phosphorus along with nitrogen, sediments and pesticides in sensitive areas (water protection zones). We have yet to see this legislation used but it certainly could be used to some considerable effect, especially if we arenćt on course to achieve the water framework directive targets. There is every chance that the DWPA legislation could be used to designate ósensitive areasô as in the case of Denmark, the reasons for designation are likely to range from nitrogen to phosphate, sediment and pesticides.

ited

1. Change Cow Diets

On the majority of dairy farms there are 2 main inputs of P ï inorganic fertiliser and bought in feed.

Historically many dairy cow diets have been formulated with an abundance of phosphate, although this is changing as the price of inorganic phosphorus rises. It has been thought that plenty of phosphorus in the diet aids better fertility and cows have been fed an excess and been offered ôhi-phosô minerals meaning that they have excreted increased levels of bioavailable phosphate in the dung. More recent research has shown this link between phosphorus and fertility to be a fallacy and the idea of high levels of phosphorus is now widely discounted by leading nutritionists.

The research clearly shows that elevated levels of phosphorus in the diet leads to more bioavailable phosphate being excreted by the cows and does not improve fertility. This can also be demonstrated in the wider industry, the vast majority of dairy cows are fed an excess of P and yet fertility is still a serious issue on the majority of those farms.

In Denmark a lot of work has been done to lower phosphorus in dairy cow diets, when the first nutrient action plan was introduced the standard recommendation for P in diets was too high and this contributed to the high P on-farm surpluses that were seen on Danish dairy farms. In 1998 the P recommendation for diets was decreased to bring it down to 4.6g/kgDM (4.6 grams of phosphate per kilogram of dry matter).

In 2002 the third (and most recent) action plan began which gave a requirement for Danish agriculture to reduce the on farm P surplus by 50% by 2015. This was felt by the majority of the industry to be a tall order, taking into account the strides which had already been taken in reducing P in the ration and so, reducing on-farm P surplus. However, to accomplish this, in 2004 the recommendations were reduced to 3.6-3.8g/kgDM which was based on more up to date science. For example Valk et al in 1999 concluded that 2.8g/kgDM was sufficient for the requirements of the 9000kg dairy cow. To assist this reduction in P surplus the government put a tax on mineral P added into feed, however it was felt by the Danish Agricultural Advisory Service to have had little effect on buying choices.

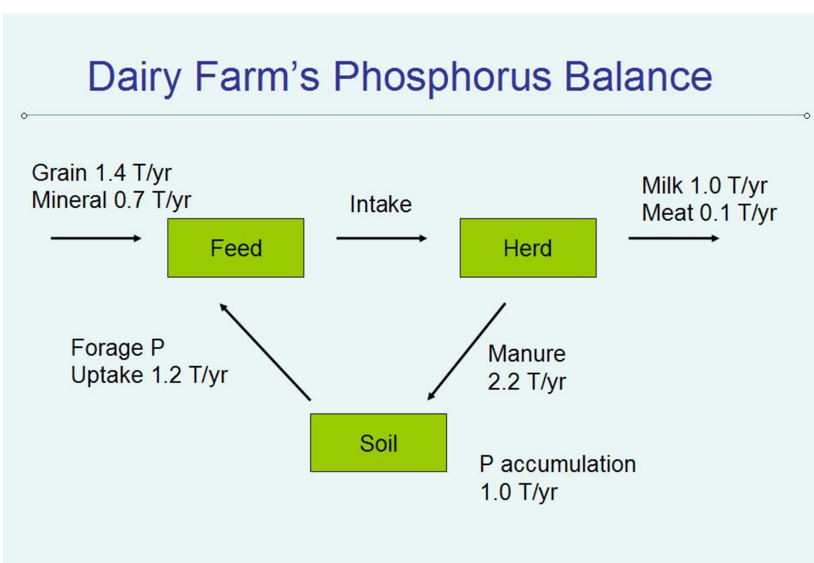
To date, this 3.6-3.8g/kgDM recommendation still stands. I understand that there was initially serious opposition from farmers to the new recommendations and that the Danish Agricultural Advisory Service have had a difficult job on their hands to get the message across. However, it now appears that the majority of Danish dairy farmers are on board and that the most significant problem in feeding cows to the recommendations for P is the P content of natural feedstuffs. In Denmark rape meal is a popular constituent of dairy diets which has a particularly high P content, other common feedstuffs such as soya, maize gluten feed and distillers grains are also high in P all with over 7.5gP/kgDM. Because of these factors, in 2006 the average level of P fed to Danish dairy cows was 4.3g/kgDM.

However, by taking the approach of reducing the amount of phosphorus in the ration Denmark has managed to significantly reduce the on-farm P surplus. In 2006 the average

3.8 kgs P per year and by the end of 2007 this figure into account the fact that up to 25kg P per ha per year can be harvested from the land, the derogation on the Nitrates Directive that they have gained means that the surplus per hectare in Denmark is between 11 and 17 kgP/ha/year. Bear in mind that if cows could be fed to the recommendation the surplus would be between 2 and 8 kgP/ha/year.

There is also important research work being carried out by the University of Aarhus into the recycling of P within the cowôs body through saliva. This is very new science and at present this mechanism including the amounts involved are not understood. The theory is that cows evolved in an environment with very low levels of available P and so, they developed a method of recycling P through their own bodies with the saliva glands playing a primary role.

In Ontario, Canada work has also been carried out in reducing the level of P fed in diets to dairy cows, nutritionist Tom Wright has been heavily involved in this work which has concluded that to manage nutrients more appropriately, producers should reduce the amount of P excreted in the manure. ñNutrition plays a key role and may be the most cost-effective approach to reduce P losses from dairy farms. By lowering P content in the diet, P output in manure is also lowered. If a lactating cow, averaging 9,100 kg milk over 305 days, is fed a diet of 3.8 g P/kg of dietary dry matter (DM), approximately 0.71 ha or 1.75 acres of cropland (mixed alfalfa/corn/soybean cropping system) is needed to recycle the manure P excreted.ò So, if dietary P is raised from 3.8 g P/kg DM to 4.8 g P/kg DM, one cow requires an additional 8.1 kg of supplemental P per year. Furthermore, 0.28 ha/cow or 44% more cropland may be needed to recycle the manure P produced with the standard Ontario type of cropping systemò (Powell and Satter, 2001). Other research has shown that cows consuming a high phosphorus diet of 0.56% (112g P/d) can excrete as much as 49.6 g P/d in their manure. This translates to 18.10 kg of manure P/year. In comparison, dairy cows consuming 0.30% (60 g P/d) excrete 22.7% less P in their manure. Generally, researchers conclude that for each g/d decrease in P intake, there is a reduction of 0.55 g/d of P excreted.



Tom Wright of OMAFRA has put together this diagram to illustrate the on-farm P balance in Ontario currently

out by AFBI at Hillsborogh (Conrad Ferris in
view from Denmark ad Ontario that our dairy cows
can thrive on much lower levels of phosphorus that we are currently used to feeding them. Ferris et al presented a paper at the British Grassland Society conference in 2007 which gave the results of a study carried out on 50 cows over 4 lactations, concluded that a ration providing 3.7g/kg DM is adequate and that at this level no significant effect was seen on fertility, feed intake, milk yield, milk composition or total ration digestibility which suggested that the reduced level of P fed had no impact on rumen function.

Recent research from Satter et al (unpublished – reported in Ferris et al 2007) showed that not only was the level of P in manures much reduced (up to 45%) by offering cows a reduced P ration, the level of P loss from manures after spreading was also reduced by up to 10 times. This is because when cows excrete high levels of excess P it is the form of Orthophosphate (or bioavailable phosphate) which is easily dissolved by water running over soil surfaces as discussed earlier in the report.

To further support the research Satter and Wu (1999) carried out a review of data from 13 separate studies and observed fertility to be unaffected by P in the diet.

In the UK we commonly formulate rations to contain a minimum 4.2gP/KgDM, clearly the research is telling us that this in excess of the cow's requirements and is contributing to the eutrophication problems that we are seeing in our watercourses. A lot of herds in the UK are fed a high percentage of maize in the diet, which has a low P contents (2-3 gP/KgDM) meaning that there is potential to feed cows in the UK close to the P levels that are coming out of research from around the world.

2. Soil Sampling and Nutrient Planning

In today's world with fertiliser prices going through the roof it seems incomprehensible that there are farmers out there not engaged in nutrient planning and targeting manure to the right fields and crops. Soil sampling easily pays for itself, the lab costs are currently around £10/field and the information that is provided is invaluable.
Phosphate (and the other nutrients) is simply too expensive to waste and nutrient planning is the first step to tightening up usage of these precious commodities.
The PLANET software is a very good (if a little complicated) and free nutrient planning software programme developed several years ago by ADAS and based closely on RB209. There are PLANET plug-ins in all the main farm software programmes and so it is readily available to farmers.

In the new Dairy Roadmap put together by Dairy UK among others, nutrient planning has an integral place. By 2010 the roadmap aims for 65% of dairy farmers to be actively involved in nutrient planning, by 2015 this figure rising to 90%. How are we as an industry going to get there? Well, I think, actually the question is why on earth aren't we there already? We know that nutrient planning pays, we know it is easy enough to employ a consultant or agronomist to produce the recommendations and advise on manure use if farmers don't want to do it themselves. One good outcome of high fertiliser

ually taking nutrient planning seriously for the first
uable and it is more important than ever to utilise it to
the best possible advantage.
The DEFRA fertiliser handbook (RB209) is in the throes of being revised, once this revision is complete then we can expect to see PLANET 2 completed which promises to be a significant upgrade from the current version.

3. New Fertiliser Products
There are new fertiliser products being developed with higher % water solubility due to improved extraction techniques. This would mean potentially that less phosphate would need to be applied for the same yield benefit. These products are very much still in trial phases and the data is commercially sensitive, but they have the potential to provide certainly part of the solution.

4. Soil and manure 'conditioner' products
The soil environment is vitally important for ensuring the correct fertilisation of plants. The idea behind fertilisation is to make up for any nutrient deficiencies in the soil to allow the soil to effectively feed the plant. This relies on a healthy, live soil with a good microbial population to make nutrients available to plant roots through the soil solution. There are a range of different products for both the soil and manure environment, some of which have received a significant amount of press recently.
If the claims of the companies are correct then they have significant potential to reduce the loss of P from land to watercourses and ultimately save money by making the huge reserves of biologically unavailable P, which is present in all soils, more available. Unfortunately there is virtually no independent research available to support the claims made by the companies selling the various products.

5. Manure Separation
Manure separation has a massive potential in improving manure phosphate utilisation efficiency besides improving manure handling and cutting down storage requirement.
The forthcoming changes to NVZ legislation in England mean that dairy farmers in 70% of England will need 22 weeks of slurry storage, which is far in excess of what most dairy farms currently have in place.
The changes also mean that if farmers are producing over 170kg/ha of Nitrogen per hectare* will need to export nitrogen (in the form of manure) off the farm.
There are a variety of reasons why these requirements are encouraging the uptake of manure separation:

- Reduce overall liquid storage requirement by 15-20%
- Produce a non-crusting liquid
- Enable the solids to be transported easily over longer distances, enabling easier export off farm.

** This level is dependant on the stocking rate derogation that DEFRA are seeking through Europe – we will not know the final figure until summer 2009 at the earliest* n a 300 cows herd and shows that the economics of ginal, it is very dependant on each individual system, which type of separator is bought and the individual costs.

Partial budget to assess the effect on annual profit of installing a separator system

LOSSES				**GAINS**			
Reduced Income	**Units**	**£/unit**	**£**	**Increased Income**	**Units**	**£/unit**	**£**
			0				
Increased Costs				**Cost Savings**			
Separator/Pump maintenance			1,000	Slurry spreading	793	1	793
Separator/Pump electricity			400	Speed of spreading	4492	0.2	898
				Nitrogen	4492	0.9	4,043
Capital				**Capital**			
Separator equipment	1	16000	1,920				0
Separator buildings	1	25000	3,750	Reduced slurry storage	531	30	1,912
Total (A)			**7,070**	**Total (B)**			**7,646**
Interest rate	7 %						
Depreciation rate buildings	5 %						
Depreciation rate equipment	10 %						
Additional Profit (B-A) =			**£576**				

So how does this fit in with phosphate recovery? Phosphate is held in tiny solid particles within slurry, in the micron range, and if the separation is effective enough this nutrient will be partioned into the solid fraction. Therefore the phosphate rich solid can be used on arable fields and soils with low P indices while the liquid is a great ókaynitroô aftercut type fertiliser with a high proportion of available nitrogen. The catch is that most separators (eg. belt press, screw press, rotating drum etc) donôt actually remove particles as small as this which means the phosphate ends up evenly distributed between the solid and the liquid.
The two methods of portioning phosphorus that are currently available are the centrifuge and chemical separation (use of polymers and coagulants).

1. CENTRIFUGE

The centrifuge is commercially available from a range of suppliers such as Alfa Laval Linton agricultural solutions and Ken Kyte, they are expensive, costing between £40,000 and £50,000 for the centrifuge, before the rest of the system such as pumps, mixers, pipework, gantry etc are costed. This method works by spinning liquid and the centrifugal force means that solid particles are separated out to the edges of the centrifuge. Centrifugal separation can partition up to 80% of the phosphate into the solid fraction.
The partial budget below shows that on the example farm the capital cost of centrifugation in often cannot be justified by financial returns, even taking into account the high value of phosphate. Again, this is based on a 300 cow herd and values will differ between farms.

e effect on annual profit
ge separator system

LOSSES				GAINS			
Reduced Income	**Units**	**£/unit**	**£**	**Increased Income**	**Units**	**£/unit**	**£**
			0				
Increased Costs				**Cost Savings**			
Separator/Pump maintenance			1,000	Slurry spreading	793	1	793
Separator/Pump electricity			400	Speed of spreading	4492	0.2	898
				Nitrogen	4492	0.9	4,043
				Phosphorus	1699	1.4	2,379
Capital				**Capital**			
Centrifuge equipment	1	60000	7,200				0
Separator buildings	1	25000	3,750	Reduced slurry storage	708	30	2,549
Total (A)			**12,350**	**Total (B)**			**10,662**
Interest rate	7 %						
Depreciation rate buildings	5 %						
Depreciation rate equipment	10 %						
Additional Profit (B-A) =			**-£1,688**				

2. CHEMICAL SEPARATION

This used metal compound coagulants or polymer flocculants to óstickô solid particles together, meaning that the particles are then larger and can be separated using an ordinary screen separator. There are concerns regarding the use of metal coagulants in slurry and the effect that these may have on soil chemistry when applied to land routinely. However, organic polymers, such as PAM derivatives and Chitosan (derived from shellfish) have been trialled extensively in research and found to be effective.

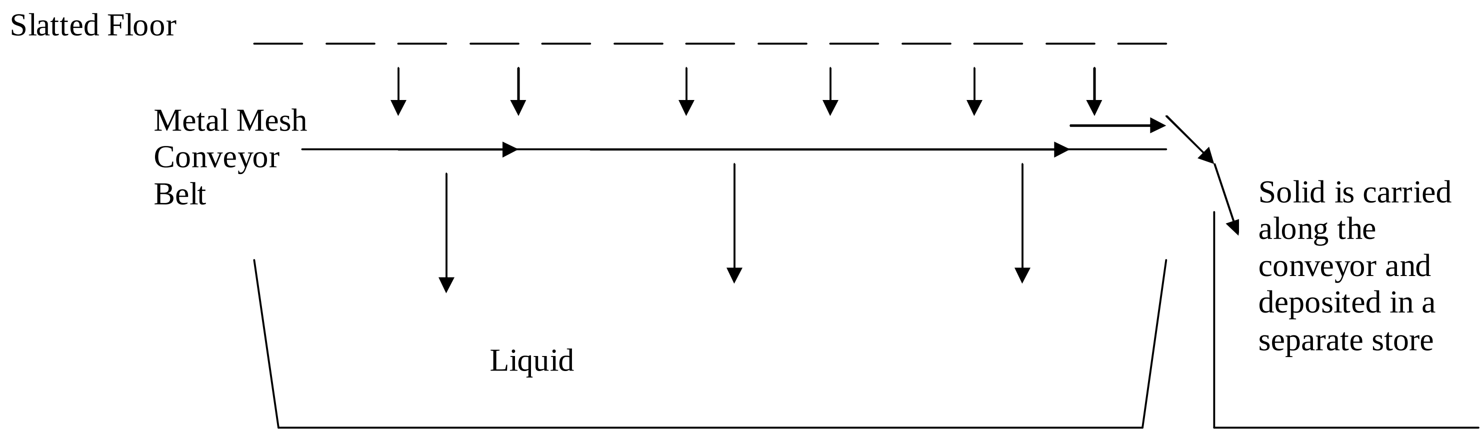
Introducing a polymer into slurry before it is put through an ordinary sieve type separator is effective at partitioning up to 80% of the phosphate into the solid fraction which leaves a non-crusting liquid ókaynitroô type liquid fertiliser and phosphate rich, transportable solid.

This type of system is currently being researched by Maibritt Hjorth, a pHD student in Denmark. She is developing an automated system, using Near Infrared Spectrometry (NIRS) to inject the polymer according to the dry matter and volume of the slurry as it passes past the sensor in realtime. This has the potential to revolutionise slurry management and the recycling of phosphate. The main drawback is the expense of the NIRS equipment, the optical sensors are extremely expensive and also fragile, which may render them unsuitable for on-farm use. However, it is a system which certainly needs to be looked out for as phosphate prices continue to rise.

There may be a case, in the interim for a lower cost system that works in a more simple way to allow us to separate phosphate from slurry, using polymers and allow us to begin to make better use of this valuable resource.

3. SOURCE SEPARATORS

Source separators are a really new development that is being researched in Canada among other countries. The idea is to install them in a pit, underneath a slatted floor in new cattale sheds. The system comprises a cambered conveyor ï sieve belt which works as shown below:



In time, this is likely to be of significant benefit worldwide in separating the solid and liquid from manures, before they mix. There are many countries where slatted floors are the norm in dairy buildings and therefore as new facilities go up there is real potential to include this type of separator. This would give almost 100% separation of phosphate.

The barrier to uptake in the UK, besides cost, is that historically we have not gone down the slatted floor route with our cattle sheds. However, in the future, as long as the cost of the system is reasonable I believe this will play a significant role in manure management in the UK.

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on Dairy Farms in the UK – Conclusions.

Fertiliser

This is a really obvious solution that has been around for years. The value of muck has never been higher and fertiliser, particularly phosphate prices have rocketed over the last 12months - at the time of writing triple super phosphate (TSP) is at £700/tonne making every kg of phosphate worth £1.49! It is essential that every farmer (regardless of sector) is engaged in regular soil testing and the planning of manure and fertiliser to match as exactly as possible the crop requirements of N P and K. There are free programmes out there such as PLANET developed by ADAS and a plethora of consultants (such as myself!!) and advisers out there to make the job easier and the savings made easily pay for the service in most cases. This is the first step and absolutely essential in todayôs climate. Gone are the days of applying 20.10.10 routinely to grassland farms.

There are new P fertiliser products being developed using different extraction methods to improve availability of P in fertiliser, thus meaning that less needs to be applied for the same result. This is still very much at an experimental stage and trial work should be starting on this in

Yara have developed the realtime N sensor to apply nitrogen variably across the field ï how long until we see sensors that deal with all 3 macro nutrients?

Recommendation:

- All farmers MUST be nutrient planning and routinely analysing soils every 3-4 years to make efficient use of the resourses that we still have.

Manure Management

This is the absolute key to getting on top of phosphate management and in my view the way forward in a world with increasingly scarce reserves.

Slurry separation is key to using phosphate sustainably and getting it to the areas that need it. Centrifugation and flocculation are the only methods currently available to tackle phosphate particles and separate a large percentage into the solid component. However, source separators may have a significant role to play in the future.

Where farms are engaged in biogas production then these separation technologies can be used on the digestate. There are other options with digestate, such as maximising struvite production.

Recommendation:

- A cost-effective and practical way to use polymers to separate phosphate from slurry is needed.

! Its quite simple, its been done in Denmark with no ill effects on fertility and numerous studies from around the world have proved that it can be done.
In the UK we have the benefit of reasonable growing conditions for Maize silage with many herds being fed a high proportion of maize silage in the diet. Because this has a naturally low P content (2-3gP/kgDM) we have much more scope than Denmark to feed cows to the levels that are being shown to be safe through worldwide research, including that done in Northern Ireland.
Mineral P included in dairy cow minerals and cake is reducing all the time and is mainly driven by the wordwide increase in mineral phosphate prices. Several mineral companies are using the environment to sell low-phosphate minerals, I have recently seen on one leading mineral manufacturerøs website:

“Dairy Cow Minerals formulated with high calcium and reduced phosphorus levels to protect the environment”

This can only be a good thing with a reduction in phosphorus levels and an increased awareness of the environmental impacts.

There is still concern over phosphorus deficiency in some herds and cow are said to respond to treatments. Leading nutritionists believe that this is actually due to Hypocalcaemia complications and the synergistic role that calcium and phosphorus play with the body. However it does highlight the fact that when feeding cows to the reduced levels of phosphorus, we MUST begin to routinely analyse forages for phosphorous content, as this can vary widely, to ensure that the physiological requirements of these high performance animals are met.

Recommendations:

- We must formulate diets to supply less phosphorus to our dairy cows, particularly through mineral phosphorus.
- We must routinely analyse forages for phosphorus content to ensure that the correct amount is supplied and avoid any accidental deficiency situations.

The Next Step

Due to the high cost of centrifuges, I am working in partnership with others to set up a UK based trial on a clientøs farm to develop a method of adding polymer to slurry before it passes through a conventional rolling screen separator to separate phosphate. When this is developed it will give dairy farmers a real, and hopefully economically justifiable means to separate, target and export valuable phosphorus from their slurry.

Well, the Nuffield has been amazing! I was a bit sceptical when I first went to the information evening in Herefordshire and everyone kept telling me it would óChange My Life.ô I wasnôt really sure I wanted my life changing thanks.

But needless to say it has, and all in very good ways.

There have been a number of trials and tribulations all the way through what with driving on the other side of the road (and forgetting to drive on the other side of the road on once scary occasion), being on the wrong half of the train, the zip on my suitcase breaking when I really needed to get some clean clothes out, being stranded on the wrong side of a motorway to the place where I had an appointment, being eaten to death by mosquitoes in Canada and all the rest, but somehow these little nightmares really made the whole experience and are what I remember and chuckle about looking back.

Since starting the Nuffield I have changed jobs, I left FWAG in December 2007 to take a job with a The Dairy Group as a dairy consultant specialising on the environmental side. Iôm doing all sorts of really exciting work, planning a study trip for farmers to Holland to look at slurry management solutions, looking at possibilities of carrying out trial work, doing more work on grassland soils which I find really interesting and plenty of fertiliser and manure planning to help our clients make the most of their manures and put into practice many of the recommendations of this report.

Other things have changed too, Iôve gained a huge amount of confidence both professionally and personally which I am sure will help to carry me through lifeôs little challenges in the years to come. All the lovely (and not so lovely!) people that I have met and fantastic places that I have visited have had a massive impact on me, gone are all my worries about travelling on my own, getting to the right place and meeting new people.