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Focus Site Project Review

Nutrient management planning on a beef and arable farm

Lower Eyton Farm, Wrexham

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Contents.

1 Summary

Lower Eyton Farm is a lowland farm in the River Dee catchment, near Wrexham. The unit compromises of arable production, 5,000 free range poultry and 320 beef cattle which are finished on straw bedding at 28 months of age. The farm extends to approximately 500 acres (202 ha), including 75 acres (30ha) of summer grazing land. The arable enterprise on the farm constitutes winter wheat, winter barley, spring barley and forage maize. Stubble turnips may also be grown in some years.

The farm includes a slurry lagoon with the opportunity available for clean and dirty water separation. As well as producing its own poultry and beef manure, the farm also has access to sewage sludge. The farm is not currently part of a Nitrate Vulnerable Zone (NVZ), however it is regarded as 'nitrate sensitive'.

Business Aspirations.

Mr Evans wanted to ensure that he was making best use of the nutrients he applied to his crops, with a view to saving costs, minimising any nutrient loss out of his farming system and into the wider environment and optimising production. An assessment of soil nutrient status was made on a field by field basis, what crop demand was, and whether proposed applications were appropriate. This information will now inform Mr Evans nutrient application regime in the future.

Nutrient Management Planning is fundamental for ensuring that nutrients are managed efficiently to save money and reduce environmental impact. It is important that these plans are practical and easy to implement on-farm on a day to day basis. Applying the correct rate of fertilisers/manures using the most efficient methods of application can reduce costs and environmental impact. Nutrient Management Plans also take into consideration priorities during different seasons of the year.

Chicken manure is a valuable nutrient source produced at Lower Eyton. Although it is a valuable resource which can reduce purchased fertiliser costs, the environmental risks can be high due to the high nitrogen levels in the manure. There are increasing concerns from Natural Resources Wales (NRW) that water quality may be compromised in areas densely populated with poultry units. Although Lower Eyton is not located in an area currently densely populated with poultry units, the risks are still present. In this case, incorporating the responsible spreading of chicken manure at the farm into the nutrient management plan was critical.

Focus Farm Project key objectives:

1. Soil testing the entire farm (200ha) in order to determine soil indices, quality and structure.
2. Analysing manures from both the beef and poultry enterprises to determine nutritive value.
3. The involvement of a soil specialist to compile a comprehensive and practical Nutrient Management Plan, bespoke to the farm and its production requirements.
4. Guidance points to be disseminated to the industry regarding:
   - The benefits of utilising a Nutrient Management Plan to its full potential.
   - The importance of good soil health for optimum grassland and crop productivity.
   - How to manage nitrate sensitive areas effectively.
   - The economic value of home produced manures.
   - How to optimise the nutrients available in chicken manure with minimal environmental impact.
   - The responsible storage and spreading of both chicken and cattle manure without compromising water quality.

1.1 Project Conclusions

The 2017 Spring soil sampling results, in conjunction with an assessment of field management activity, cropping regime and nutrients used, by a qualified specialist resulted in the following conclusions:

- **Soil sample results.**

The soil samples indicated that lime is needed on 19 of the 35 fields assessed. Restoring soil pH to pH 6.0 would be beneficial to the grassland swards and to 6.5 for any arable fields. **A focus should be on improving the grassland fields which have a pH below 5.8 and the arable fields below 6.5. This is the priority action for the farm.**

- **Phosphate levels.**

Two of the fields sampled have a P index of 4. This is high and no additional phosphate should be applied to these fields either as inorganic fertiliser or from applications of organic manures. No P fertiliser or organic manures should be applied to these fields, until the soil P index has fallen. **Applying additional P to these fields will increase the risk of diffuse pollution taking place.**

- **Magnesium levels.**

Two fields have low soil magnesium levels and magnesian limestone (rather than ground limestone) could be considered for these fields. Magnesium is an essential component for the production of chlorophyll and photosynthesis,

- **Varying fertility levels across the farm require a field by field approach.**

There is a wide range of soil fertility across the farm ranging from index 1 to index 4 for P (phosphorus) and index 0 to index 4 for K (potassium). Inputs need to match crop need based on the soil fertility and the crop being grown and should not be applied as a standard/routine application. **Matching inputs to crop requirement will make and save the business money as well as protecting the environment.**

Whilst matching nutrient applications to crop requirements on this farm frequently related to reducing specific inputs, the converse can apply. Based on the soil analysis which was undertaken in March, it appears that despite applying a basal dressing of P and K this has not met winter cereal crop requirements and additional inputs should have been applied.

- **Ensure that application rates stay within those recommended within the Code of Good Agricultural Practice.**

The Code of Good Agricultural Practice for the Protection of Water, Soil and Air for Wales currently states that, to reduce leaching losses from manures, one should not apply more than 250 kg per ha (200 units per acre) of total nitrogen in organic manures in any 12 months. Application rates have exceeded this on some fields. Ensuring this ceiling is adhered to will help make cost savings in the business, and reduce pollution risk.

An example would be the application of nutrients onto the maize field in 2017. The recommendation is to reduce nutrient applications to just FYM and omit the planned application of sludge cake and digestate, in order to ensure the total N applied falls within Good Practice.

- **Using urea fertiliser more effectively.**

It is recommended that Mr Evans only uses coated urea fertiliser (his nitrogen fertiliser of choice) in the spring when temperatures are cool and little volatilisation takes place. Using it outside of this period results in a higher risk of leaching into the wider ecosystem, and a cost without return to the business.

- **The importance of routinely soil sampling to match nutrients with crop requirement.**

Soil analyses for pH, N, P, K and Mg every 3 to 4 years should be undertaken, as part of business management. This is especially important as large volumes of organic manures both home produced and imported are used on this farm. Where large volumes of organic manures are applied more regular testing is recommended.

Target values to maintain are pH 6.0 for continuous grass and Index 2 for soil P, and 2- for K.

- **Other key recommendations:**

Target spring applications of organic manures where possible to maximise the available nitrogen for crop growth.

Sample the herbage for % total S and the N: S ratio to see if sulphur deficiency is an issue at Lower Eyton.

Maintain an on-going field record of manure use, together with any inorganic fertiliser applications. Re-directing organic manures at lower index fields will help balance soil nutrient levels on the farm.

1.2 Take home points for the industry:

- Taking a field by field approach when looking to maintain/improve soil nutrient status will help optimise farm productivity.
- Start with soil sampling, send them off for analysis, and then build up your nutrient application plan from these.
- Shifting to a crop requirement methodology will help you assess soil nutrient status, and ensure you apply the appropriate levels of nutrients. This will result in better use of home produced and bought in fertilisers, ensure crop production is optimised, and reduce resource losses into the wider environment.
- These principles are obligatory within an NVZ area, but represent good agricultural practice i.e. benefitting the business profitability, irrespective of whether in an NVZ area or not.
- Lower Eyton is typical of farms in Wales'; 50% of its fields had a pH lower than that recommended for optimum crop production. Without the optimum pH, the ability for the crop to access nutrients already present, or applied by the farmer, to the soil is inhibited.
- Sludge cake and digestate are excellent sources of applied nutrients, but regular applications of sludge cake can result in excessive phosphate levels in soil, resulting in losses of nutrients to the environment. Before application, undertake a soil sample analysis, and base fertiliser type and volume on these results.
- If fields have lower than optimum pH, AND are low in magnesium, use magnesian limestone to resolve both issues. Do not use magnesian limestone unless you have a magnesium soil deficiency.
- Remember to operate within the principles of the Code of Good Agricultural Practice, which encourages a sustainable soil nutrient management approach.
- In order to reduce leaching losses from manure applications, do not apply more than a total of 250kg/ha (200 units/acre) N from organic manure in any rolling 12 month period.
- Use the revised RB209 Nutrient Management Guide to help you calculate applications onto fields, and discuss it with your adviser.

2 Business Review

The business review was undertaken using detail provided in order to compile a nutrient management plan.

Lower Eyton Farm extends to approximately 500 acres (202 ha) that includes 75 acres (30ha) of summer grazing land. The land is located in a number of blocks with the furthest land being located around 7 miles away. The soils around the farm are predominately medium textured soils.

None of the farm is located within a Nitrate Vulnerable Zone, but Mr Evans is keen to ensure that his nutrient management practices both optimise productivity and minimise loss of nutrients to the wider environment.

Eyton Hall Farm is a mixed beef and arable holding and cropping generally comprises of:

Winter wheat 69 ha

Winter barley 57 ha

Spring barley 12 ha

Forage maize 12 ha

Stubble turnips may also be grown in some years.

The livestock enterprises on the farm comprise around 300 beef cattle. Around 150 young cattle are purchased each year and sold at around 24 months old. Therefore at any one time there are around 150 cattle aged up to 12 months and another 150 aged 12 -24 months on farm. The business also supports a 5,000 free range laying chicken enterprise.

The cattle are all loose housed on straw but around 50 of the older cattle also have access onto open yards for feeding and loafing, therefore both FYM and a limited amount of slurry is produced on farm. The slurry is scraped into a slurry lagoon from where it is applied when ground conditions are suitable. Slurry is applied by a vacuum tanker.

Sludge cake and liquid digestate is imported onto farm, the digestate is applied using a trailing shoe and the sludge by means of a rear discharge spreader. The free range hens are on a 14 month cycle and the shed is cleaned out and spread at the end of the 14 month cycle (which results in the application of around 60 tonnes of layer manure for each cycle).

Unless a compound fertiliser is used the majority of the nitrogen applied is in the form of coated urea. Although the recommendation is to only use urea in the spring, Mr Evans intends to use this as his fertiliser of choice, as he believes it works well for his system, and is competitively priced.

2.1 KPIs and business performance indicators

KPIs and business performance indicators were not a key focus of this project, as it primarily related to optimising soil productivity for a mixed farming system in a nitrate sensitive area.

2.2 Potential impact of the project on business

The project will help ensure that Mr Evans is making best use of his home produced fertilisers, i.e. from both the cattle and the chickens, and only buying in fertilisers that are required. Moving from routine purchasing of fertilisers, to a purchasing protocol based on soil status and crop requirement will help ensure that the business is getting maximum returns for the investments made.

The project will also help ensure the farm is operating with environmentally safe limits, as regards nutrient loading of the natural environment. Operating with the recommendations of the Code of Good Agricultural Practice will help the business operate more effectively, both economically and environmentally.

3 Project Review

3.1 Aims of the project

Mr Evans wanted to investigate soil nutrient availability and crop requirements on his farm, and adjust his fertiliser application regime to optimise production, and save costs on inputs, if possible.

He was also interested in optimising the nutrients available in home produced chicken manure, whilst minimising environmental impact. Recommendations on the responsible storage and spreading of both chicken and cattle manure without compromising water quality was also a project feature

3.2 Key project results and discussion

	Recommendation to business	What was the project result?	Good practice.	Tangible financial cost/impact?
1	Minimise poultry manure resource losses pre application	The 60 tonnes of poultry manure produced should be applied immediately as it is taken out of the poultry shed, but this may not be practical every time. The system is on a 14 month cycle, so changeover will not necessarily coincide with field preparation activities. If the manure needs to be stored, effective storage will secure its fertiliser value, and minimise health and pollution risk.	If storing the poultry manure, use a covered stockpile, either with a roof or plastic sheeting. Use of an impermeable base and bunding. Narrow stacking, no more than 1.8m high, to reduce emissions from overheating. Located on a well-drained site away from water courses.	Storing poultry manure under cover will eliminate any potential for leaching of nutrients to take place. Based on current fertiliser prices a ton of poultry manure (40% D.M.) is worth £16.98p. 60 tonnes of poultry manure is worth approximately £1,019 at today's fertiliser prices. Utilising the nutrients in the poultry manure effectively can potentially reduce the amount of inorganic fertilisers needing to be purchased.
2	Take pH levels to 6.0 for continuous grass and 6.5 for arable.	Applications of lime required on 19 fields, and addressing this should be a priority.	Application recommendations per field as provided in the nutrient management plan. No more than 3 tonnes/acre to be made in any single application. Lower doses of granulated products not recommended. Use magnesian limestone only on the 2 fields with a magnesium deficiency, and use ground limestone on the remainder.	Research has shown that there can be a 9% loss in dry matter production in swards with a pH less than 5.5 (source DEFRA) If the pH is wrong, nutrients applied may not be available to the crop, instead being lost through the soil, incurring costs and run-off issues. The addition of lime helps to release soil nutrients where the soil pH is low. Fertilisers and manure cannot be fully effective if the land is short of lime. Water that leaches from acid soils may contain undesirable materials which can adversely affect the quality of surface and groundwaters.

	Recommendation to business	What was the project result?	Good practice.	Tangible financial cost/impact?
				The benefits of liming may vary but the greatest returns will be achieved by maintaining the soil pH in a narrow range within 0.2 units of the optimum pH value. When the cost of lime is related to the long term benefits, it is one of the best investments a farmer can make.
3	N, P and K requirements. A range of recommendations, dependant on individual field soil status, and crop requirement.	Assess N P and K requirements for all arable fields, prior to field preparation. The project indicated that all winter cereal fields were deficient in K, and several in P.	Bespoke fertiliser recommendations on a per field basis. Calculation of crop requirements, the contribution from any manure applied, and then a balance to be supplied from bought in fertilisers.	Taking account of the nutrients applied from an application of organic manures and deducting these from the crop need will potentially help reduce the amount of inorganic fertilisers needing to be purchased. Every ton of cattle FYM is worth £6.40 at today's fertiliser prices. Assuming the cattle are housed for 5 months each winter the 300 cattle will produce FYM worth £4,580 at today's prices. Targeted use of this FYM will potentially save the business this value of inorganic fertilisers.
4	Only apply additional P and K to meet crop requirements, not on fields with high Pand K indexes.	Various recommendations, across 25 fields. Including: One winter wheat field is P index 4. Do not apply any more P to this field via bought in or home produced fertiliser until the index is back to 2). Care needs to be taken with another winter wheat field with an application of 25t/ha sludge cake applied, that P applications do	Where the P index is 3 additional phosphate is not required for optimum crop growth for winter wheat. Applying organic manures is not recommended as the phosphorus levels in the soil will continue to increase. If the soil potassium reserves are low and additional potash fertilisers are required it is recommended that an inorganic potash fertiliser be	Applying additional inorganic fertilisers rather than home produced organic manures may increase direct costs to the business, however by applying the specific crop need this will ensure optimum crop growth and protect the environment.

	Recommendation to business	What was the project result?	Good practice.	Tangible financial cost/impact?
		not exceed crop demand, as index is already 3.	applied rather than organic manures.	
5	Put on straight applications for specific N or P or K requirements, if the soil indexes exceed optimum.	Various recommendations, across 35 fields. Including: 4 winter wheat fields are at or above the optimum index for P and K, with applications of sludge cake and FYM providing the maintenance levels of P and K required. Therefore only straight N is required to meet crop requirements, rather than a NPK compound.	Only apply the recommended amount of fertiliser to meet crop requirement, in order to optimise investment, and minimise pollution.	A reduction in cost of fertiliser application, as straights are cheaper than compound fertilisers, per unit price. This will save the business money where current practice is to apply nitrogen as part of a compound fertiliser.
6	Use the parameters regarding total organic manure N applications in CoGAP, to optimise production and minimise losses to the environment	Calculate the total kg/ha total N from organic manure onto each field. If more than 250kg/ha, then the practice has a negative impact on the environment. Results show that Mr Evans can reduce inputs into several fields, in order to meet this criteria and save money. Savings will be made by reducing the volume of sludge cake and digestate bought in.	Ensure that the total kg/ha total N from organic manure onto each field is not more than 250 kg/ha.	There is unlikely to be any cost savings to the business, there may indeed be an increase in inorganic fertiliser application in order to meet crop requirement. However, there will be environmental benefits associated with the outlined CoGAP practice, as crops are able to utilise nutrients from inorganic fertilisers more effectively than those from organic manures.

3.2.1 SWOT project analysis

STRENGTHS	• Detailed analysis of the soil nutrient status, and crop requirements. • Depth of knowledge increased as a result of the NMP as regards nutrient management, on a field by field basis. • Capacity to reduce spend on bought in nutrients, and optimise production from those applied. • If acted upon, the NMP provides the basis for Mr Evans to improve business performance, and minimise the farm's impact on the wider environment. • Improves business management skills, encouraging business practice to be based on maintaining and improving soil condition, and working to a crop requirement principle. • Ensuring that productivity is principally based on home produced nutrients, using bought in nutrients only as and when required, saving costs.
WEAKNESSES	• A soil condition/crop requirement approach requires on-going soil and manure sampling. There is a financial cost and farm labour resource implication to this. • A bespoke field by field system may be more time consuming than applying a one size fits all approach. • There may be a short term increase in costs, relating to getting fields to optimum pH.
OPPORTUNITIES	• Better soil condition as a result of optimising soil nutrient status. • Long term cost savings now possible if enact a strategic use of nutrient resources. • More production from grazed grass and home-grown feeds long term. • The ability to evidence that the farm is operating in an environmentally responsible fashion, by undertaking an NMP, and implementing it. • The above is even more relevant if an ongoing soil/manure sampling and planning approach is taken. • Use of time for other farming practices.
THREATS	• Substantial price increases for inputs, discouraging farmers to invest in soil management. • Farmer capacity/willingness to participate long term in nutrient management planning, unless supported by public funding (which may be at risk post Brexit).

3.2.2 Alignment to sector's strategic goals

This work contributes to the Welsh Red Meat Sector's strategic objectives, specifically in relation to:

- Improving on-farm output from the red meat sector by at least 7% by 2020, by helping to contribute to increasing the national average herd performance.
- Develop new business focussed programmes to improve the management, efficiency and profitability of Welsh red meat businesses.
- Establish mechanisms that will maximise outputs from grass based systems and reduce reliance on bought in (imported) feed.

- Inform/educate the industry about cost saving/conservation, energy and water efficiency, ways to reduce waste and ways to improve knowledge, openness and transparency.

4 Impact on the industry

4.1 Impact on individual business

For the full summary list of the impact of the project on the business, refer to the Project Conclusions in section 1.1 of this report.

The project has revealed that although the farm has yet to implement the recommendations of the NMP report in full, there are significant cost savings to be made, once soil nutrient status and crop requirements are used to determine nutrient applications on grass/arable crops.

In addition to this, undertaking an NMP, and putting its recommendations into practice helps to proof the business as regards its impact on the wider environment, as well as ensuring that its own resources (soil/water/air) are protected long term.

The process of completing and implementing an NMP at Lower Eyton shows the value of taking a field by field soil status approach to nutrient applications, irrespective of whether one is in an NVZ.

4.2 Impact on wider industry

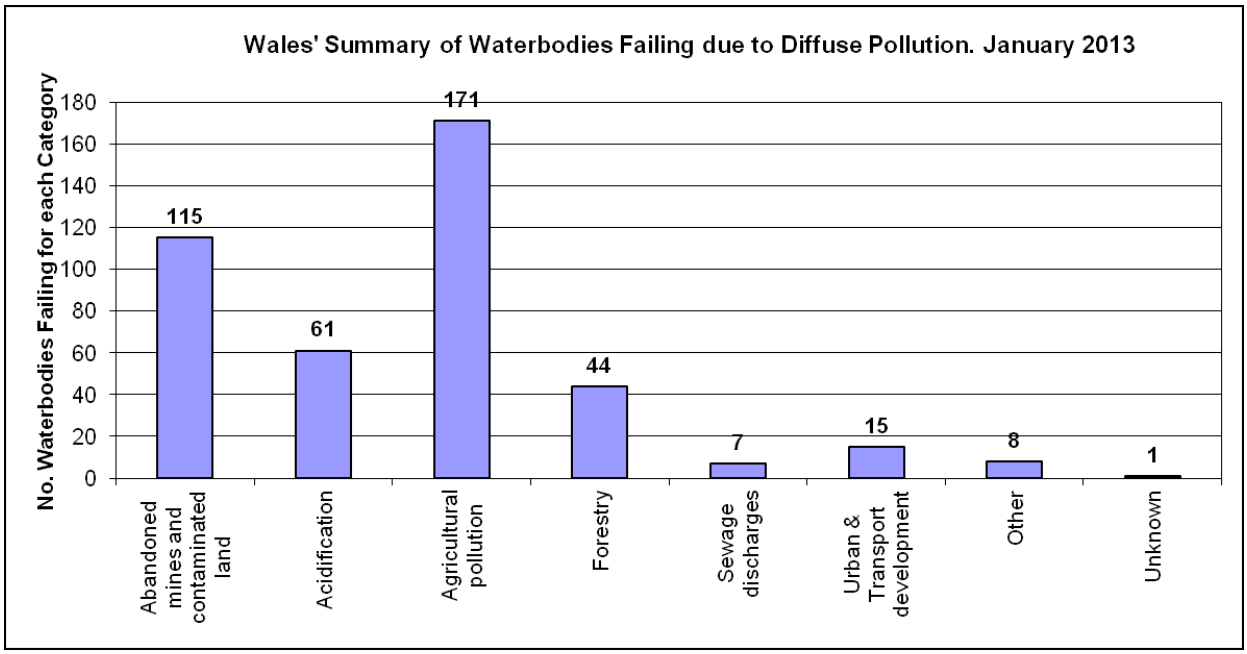
4.2.1 How typical is Lower Eyton to the rest of the industry in Wales?

Lower Eyton is representative of many livestock farms in Wales, especially in relation to optimum pH, P and K levels. Results from 1,500 fields sampled through the Wales Catchment Initiative showed that there is room for significant improvement for maximising returns from Welsh farmland:

- 64% of fields had a soil pH less than 6.0
- 67% of fields did not have optimum levels of P (21% had a P index of 0 -1 with 46% at index 3 or above)
- 55% of fields did not have optimum levels of K (39% had a K index of 0-1 with 16% at index 3 or above)
- 76% of fields did not have optimum Mg levels (around 2% had a Mg index of 0-1 with 74% at index 3 or above)

4.2.2 Environmental benefits of better on farm nutrient management.

Where there is no distinct single point of discharge, and pollution enters the water by a number of pathways, this is known as **diffuse pollution**. In Wales, agricultural activities can cause significant diffuse pollution problems, if good practice is not followed. The main water quality problems associated with diffuse pollution from agriculture relate to the loss of nutrients such as phosphorus and nitrogen, pesticides and other agrochemicals and faecal microorganisms. Soil erosion is also an issue in some areas, particularly where sloping grassland or river banks are poached, with phosphorus, ammonia and faecal microorganisms associated with the loss of sediment.



The above graph shows the impact agricultural diffuse pollution has on Wales' waterbodies, relative to other diffuse pollution sources.[1]

4.3 Take home points for the industry.

Take home points for the industry from this specific project are provided in the Summary section of this report.

An additional summary of helpful rules of thumb for the industry is below. These will help ensure you make best use of your nutrients AND will minimise any negative impact on the wider environment:

Always

✓ Ensure there is no risk of run-off.

✓ Prepare and follow a manure management plan, and a nutrient management plan.

✓ Limit applications to no more than 250kg of total nitrogen on any given hectare in any 12 month period; this does not include manure deposited from grazing animals (and the threshold is higher if using certified compost or applying in an orchard).

✓ Check waterways frequently, during and after spreading.

✓ Leave at least three weeks between applications to avoid surface sealing and to allow the soil time to absorb the nutrients.

Never

✗ Apply when run-off to a waterway is likely to occur.

✗ Allow silage effluent, slurry, manure or fouled water to enter a waterway.

✗ Apply liquid organic materials when heavy rain is forecast within 48 hours. Rainwater that runs off fields that have recently been spread with slurry may also cause pollution.

✗ Apply more than 50m^3 (50t) per hectare in any one application.

✗ Apply to land that is flooded or likely to become flooded.

[1] https://naturalresources.wales/media/4059/diffuse-water-pollution-in-wales.pdf

✓ Observe due diligence in the use of slurry and FYM particularly in the growing and harvesting of ready to eat crops to protect public health. ✓ On tillage land, soil incorporation soon after application will reduce the risk of surface water pollution. ✓ Check that equipment is good working order and calibrated to give a known application rate and uniform spread pattern.	✗ Apply to waterlogged ground. This is where water appears on the surface of the land when pressure is added. ✗ Apply to compacted ground. ✗ Apply when field drains are running. ✗ Apply to fields that are cracked down to drains or backfill. ✗ Apply to ground that has been frozen for more than 12 hours or is snow covered. ✗ Spread within two metres of the centre of the hedge.

With reference to application methods, not covered in detail in the NMP for Lower Eyton, but important for the wider industry, the following is a useful guide.

Good practice when applying livestock and organic manures to land.

It is **good practice** for all liquid organic materials to be spread close to the ground using inverted splash plate spreaders, this is **compulsory** in an NVZ. Applying liquid organic materials using trailing hose, trailing shoe or shallow injection equipment will allow even application, minimise ammonia loss and reduce crop/sward contamination compared with conventional surface broadcast techniques.

Check all equipment is in good working order well before field activity starts. Carry out repairs as necessary, and undertake regular spot checks. Set up spreaders according to manufacturers' instructions, and adjust to an appropriate application rate and uniformity of spread for the type of manure. Match application widths to ensure even application. Avoid spillages while you are filling and moving equipment around the farm. Spillages on the road may be an offence and run-off entering surface water via highway drainage is a key risk.

If you use a broadcast technique (splash plate) then use a low trajectory and large droplet system.

Liquid organic manures should be incorporated into bare land or stubble as soon as possible to reduce odour, ammonia loss and the risk of run-off.

Solid manure should also be incorporated to bare land or stubble as soon as possible, aiming to complete the work within 24 hours.

Incorporating slurry and solid manure by ploughing is more effective at reducing odour and ammonia emissions than other techniques such as discs or tined equipment.

4.4 Impact on Welsh Government's cross cutting and priority themes

Climate change

Soils are fundamental in supporting food production and biodiversity (i.e. habitat for valued plants, animals and micro-organisms); storing carbon; and regulating greenhouse gas emissions and the flow of water in streams and rivers. The maintenance and protection of soils (as well as water and air) is critical in reducing/controlling GHG emissions.

The varying quality of forage available after often increasingly unpredictable summers and the increasing cost of imported fertiliser and feeds will make managing soil and home grown nutrients (FYM/slurry etc) to optimise production for the long term, even more critical.

If the principles of this project are adopted more widely, they will contribute to a reduction in emissions from nutrient applications. This will help reduce nitrogen use and methane production per unit of meat produced across the sector as a whole[2].

Future Generations

Ninety five per cent of the world's food production is reliant on soil; and agricultural production from UK soil is worth £5.3bn per year. Soil is home to a quarter of the earth's biodiversity including earthworms, fungi and bacteria, which maintain its fertility and provide raw materials for the medical industry.

Over 60% of agricultural soil in Wales does not have the correct pH levels for optimum crop production[3]. Assessing soil pH levels is an essential part of good land management, and this project helps to disseminate this good practice, in order to help secure food production and environmental protection in Wales long term.

The project encourages young farmers who are working in the sector to be forward thinking and to grasp opportunities to run a business more efficiently. This includes reducing cost, and potentially labour and time; all are increasingly important post Brexit in such a volatile industry.

Tackling Poverty

More cost efficient business practices result in the potential for increased returns, whether that be from on or off farm income.

[2] http://www.nutrientmanagement.org/what-we-do/tools/feed-planning-for-sheep-and-cattle/
[3] Getting the Most from your Soil; a practical guide to maximising cultivated land resources, 2015, HCC and NRW.