



THE FERTILIZER ASSOCIATION OF IRELAND



Proceedings of Spring Scientific Meeting 2018

“Sustainability through efficient use of fertilizer”

6th February 2018

Horse and Jockey, Thurles, Co. Tipperary

History of the Fertilizer Association of Ireland (FAI) 1968 -2018

Jeremiah Murphy & Noel Culleton

How sustainable are Irish dairy farms?

James Humphreys

Soil phosphorus management and water quality in two agricultural catchments

Noeleen McDonald

Beef farming on low fertility soils

Paul Delaney

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Publication No. 53

FERTILIZER ASSOCIATION OF IRELAND PRESIDENTS

<u>Name</u>	<u>Year</u>	<u>Name</u>	<u>Year</u>
Dr T Walsh	1968	Mr R Walsh	1993
Mr WJC Milne	1969	Mr J Gavin	1994
Mr G Foley	1970	Mr J Murphy	1995
Dr JN Greene	1971	Mr L Larkin	1996
Mr EJ Sheehy	1972	Dr N Culleton	1997
Mr JC Brogan	1973	Dr P Barry	1998
Mr T James	1974	Mr B Barnes	1999
Prof DM McAleese	1975	Mr C Watson	2000
Mr S McCann	1976	Mr M Cunningham	2001
Mr M Roche	1977	Mr P Drennan	2002
Mr G Cussen	1978	Mr J Carroll	2003
Mr WE Murphy	1979	Dr T Storey	2004
Mr P McEnroe	1980	Dr B Coulter	2005
Mr T Fingleton	1981	Dr B Coulter	2006
Mr J Leonard	1982	Mr J McGrath	2007
Mr P Duffy	1983	Mr T Carroll	2008
Dr M Ryan	1984	Dr JJ Fleming	2009
Mr P Keane	1985	Mr K Murphy	2010
Dr JF Collins	1986	Mr K Murphy	2011
Mr M Stanley	1987	Dr STJ Lalor	2012
Mr W O'Brien	1988	Dr STJ Lalor	2013
Mr T King	1989	Mr P Casey	2014
Mr G Leonard	1990	Mr P Casey	2015
Dr TF Gately	1991	Mr PJ Browne	2016
Mr LT Stafford	1992	Mr PJ Browne	2017



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History of the Fertiliser Association of Ireland (FAI) 1968-2018

Jeremiah Murphy¹ & Dr. Noel Culleton²

¹Target Fertilisers, Co Wexford,

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Introduction

The early development in Irish agriculture was slow, but by the mid 1960's, output from farms was beginning to improve. At this time much of the early theories behind soil science were being unravelled and the connection between soil fertility, fertiliser, lime usage and increases in stocking rate and crop yields were reasonably well understood. Nonetheless, soil fertility levels were still shockingly low and fertiliser sales were still inadequate to allow soils to reach their potential productivity. Consequently the carrying capacity for livestock on farms was very low compared to modern times. At this time there was virtually unanimous agreement between all agriculturalists that increased use of fertilisers was a key factor for the nation's endeavour to expand agricultural output.

Accurate figures for soil fertility status are hard to come by for the late 1950's, but by the late 1960's phosphorus (P) and potassium (K) levels were still low. In 1964, the average soil P and K levels were 3.2 and 50 ppm, respectively. In modern terms, the mean P and K levels were both around Index 1. The average soil pH on permanent pasture was 5.86. In 1964, the total population of cattle was just under 5 million, made up of around 1.4 million cows and a little over 3.5 million other cattle. At this time just over 34,000 tonnes of nitrogen (N) fertiliser was used. Against this background, it was clear to leaders in the agricultural sector, that while significant progress had been made, Irish soils were still falling well below their production potential and more needed to be done. Dr. Tom Walsh, Director of An Foras Talúntais, in conjunction with leading staff members in the Department of Agriculture, the advisory services, farming organisations and the fertiliser trade came together and decided to set up a new organisation, with fertiliser use and efficiency at its heart.

Formation of the Fertiliser Association of Ireland in 1968

The *Fertiliser Association of Ireland* (FAI) was established in 1968, and its first president was Dr. Tom Walsh. The objective of the FAI was straight forward; "To promote the efficient use of fertiliser in producing quality food economically". It was also to provide a forum for the exchange of scientific and technical information in relation to the production and use of fertilisers, including lime. The

practical aim was to promote the efficient use of fertilisers by meetings, field visits, and conferences, and the publication of technical information.

In many ways, it is a unique association, by virtue of the fact that the make-up of the FAI Council is spelled out in the articles of its constitution, which was drawn up early in the life of the association. The constitution lays down that members must be drawn from all sections of the agricultural industry, representing research, advisory, farming, administrative, wholesale and retail sections of the trade. No one sector could hold sway, thus ensuring that debate within the FAI council was always fair and balanced, despite the often-competing interests of some sectors. Over the years, this balance on the council has proved invaluable. Scientists were kept grounded by the practical concerns of farmers, while the trade and the farming sectors were kept up to date by meetings that introduced and clarified the latest scientific thinking.

1968 to 1978 - the early years

The FAI quickly got to work, and one of the early decisions was that all proceedings of scientific meetings would be published in full. A flavour of some of these papers published at the time include; a paper on a fertiliser use survey by well-known agronomist W.E. Murphy, a paper on the economics of fertiliser use by economist, Brendan Kearney, a paper by leading scientist of the day Aidan Conway on beef production present and future and papers on liming practice, and policy & fertiliser needs of the seventies by J C Brogan.

Fertiliser sales surged in the late 1960's-early 70's, however, Ireland's entry to the European Economic Community (E.E.C) in 1973, which proved to be a major benefit to Irish Agriculture in the long term, coincidentally coincided with a sharp drop in fertiliser sales in 1974. This was due to a combination of rapidly escalating fertiliser costs and falling cattle prices. It should be said that the drop off in sales was not as dramatic as that witnessed in other European countries during this period. By 1978, volume of sales had recovered. This would suggest that Irish farmers now appreciated the value of good soil fertility and the necessity to use fertilisers to improve productivity.

1979 to 1988 - wider dissemination to the farming community

In this era, the FAI's winter scientific meeting coincided with the annual general meeting and the annual dinner. The FAI council also felt that a mutual understanding between the various sectors on the council and ordinary members of the association could be further enhanced by having some agricultural field outings. Invariably the field trips were in the morning to various agricultural colleges and Irish research centres and to farms displaying a high degree of efficiency in dairying, tillage, beef and sheep production. These outings were very popular for the FAI membership and wider farming community as they were

organised at various locations around the country. These field trips were usually followed by golf outings in the afternoons where further discussions and ideas were often developed, often with up to 50 members attending.

Around this time the Ploughing Championship was rapidly becoming a major event in the Irish calendar with massive numbers of farmers attending. The FAI decided to mount a stand at this event, in order to promote efficient fertiliser use for profitable farming. This involved considerable commitment by the association's rank and file as, a stand had to be manned all day for three days (Figure 1). This event proved to be highly successful for several years.



Figure 1. Photograph depicting how the FAI stand at the National Ploughing Championships looked in the late 1980'sies.

While the scientific meetings proceeded, it was strongly felt by the FAI council, that more was needed to be done to bring the message of efficient fertiliser use to farmers. A decision was made to introduce a fertiliser supplement that would be published in an early spring edition of the Irish Farmers Journal. The Irish Farmers Journal embraced this idea with enthusiasm and the Fertiliser and Machinery Industry supported this supplement with advertising. The pattern was set and each year the supplement was published. The supplement generally contains up to 10 articles written on a range of relevant fertiliser-related topics. These topics were selected annually by the FAI council and relevant experts in the various areas were approached to write the articles. This format has proved to be highly successful. Farmers and students alike read them avidly, to the extent that they were often read, and stored away for future reference.

However, the backbone of the FAI continued to be the annual scientific meetings. The format for these meetings are that three to four formal papers are presented on the day, and these papers, fully edited and appropriately referenced are published annually in the proceedings of the FAI Scientific meetings. Some of the topics

tackled during this decade include an article on fertiliser use by Liam Stafford (IFI) an article on trace elements by Garry Fleming (Teagasc, Johnstown Castle). Willie Murphy and Mal O’Keeffe (Teagasc Johnstown Castle) wrote a few papers on fertiliser surveys. Donal Mc Carthy, (Teagasc, Moorepark) and Prof. Gerry Boyle AFT, and well-known sheep researcher, Seamus Hanrahan also published papers during that decade. Marie Sherwood (Teagasc, Johnstown Castle) and Austin Morgan (UCD) were amongst the first to write papers on the effects that over-use of fertilisers could have on water quality.

1989 to 1998 – heightened environmental awareness

Over this decade the usual obligations of the FAI were carried out with enthusiasm. The Irish Farmers Journal – Spring Fertiliser Supplement was continued and expanded with great success. The ploughing match obligations were also successfully carried out up until 1995. However the Ploughing Championships invariably took place in mid- to late- September, at a time when the fertiliser season was closing off and the FAI council felt that it was better to focus their attention on the spring time and further enhance the Spring Fertiliser Supplement and associated events.

Around this time a serious problem was emerging in agriculture and the environment. It was becoming apparent that water quality in our rivers and lakes indicated deteriorating status. While there were many explanations put forward for this, such as escape of nutrients from municipal waste plants, domestic sewage, nutrient escape from farm yards, there was recognition that some of the blame could be laid at the door of agriculture and nutrient management practice. Where there was over-use or inefficient use of fertilisers, or indeed spreading fertilisers (or slurry) at the wrong time of the year, or when heavy rain was imminent an increased potential for nutrient loss was more likely. The FAI realised that, in the long-term interests of fertiliser use, a more environmentally friendly approach was needed. Against this background a voluntary code of practice for fertiliser use on farms was developed and published in 1991 (Figure 2). It was the first of its kind in Ireland and was hailed by the industry as the way forward. The FAI was widely thanked for this timely initiative.

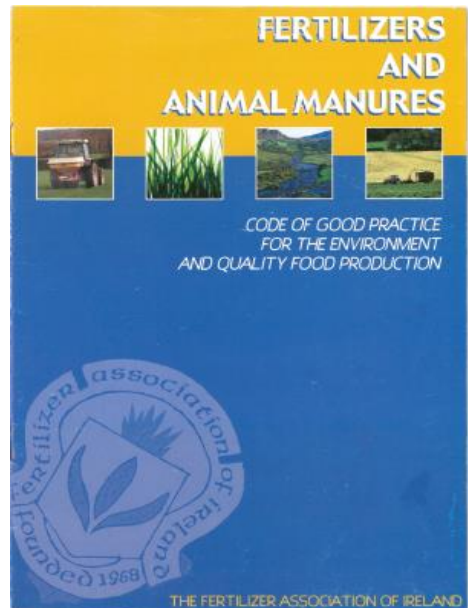
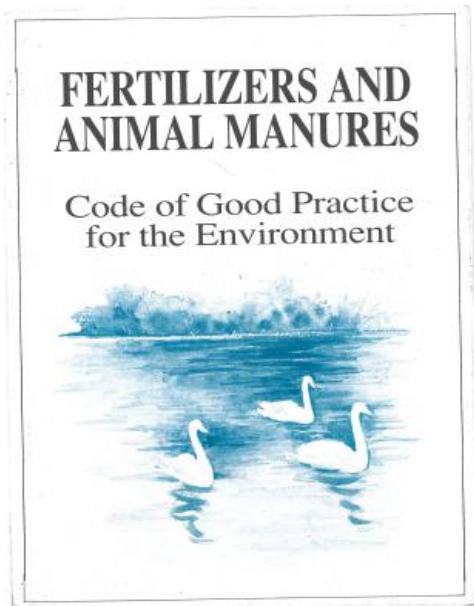


Figure 2. Code of good practice for fertiliser and animal manure use on farms. First edition published in 1991 and update in 1999.

The potential for water pollution was very serious at this stage and in 1995 the government of the day introduced the 1st Rural Environmental Protection Scheme (REPS), which had strict guidelines for nutrient management. This was a five-year voluntary programme for farmers and was followed by a further three REPS programmes and since by various environmental schemes (AEOS & GLAS) that lay down strict guidelines for fertiliser use and farm management. Because many farms do not participate in these schemes the FAI continued to promote their Code of Good Practice and in 1999, they published an improved and more up to date version.

The FAI saw a further need to educate young farmers about nutrient management and in 1995 they introduced a Fertiliser Management Trainee Scheme. The best individual students selected from successful participants of the scheme in each Teagasc Training Centre were presented with their award by FAI council members. As was now normal, the Scientific Meetings continued through this decade. Amongst the papers presented were a paper on *Irish food production* by Matt Dempsey (Editor of The Irish Farmers Journal), *Trends in phosphorus usage* by Hubert Tunney (Teagasc, Johnstown Castle) as well as papers by Noel Culleton, Kevin Reidy, Tom Jago, Myles Rath, Mike Magan and Tony Fortune.

1999 to 2008 – introduction of environmental legislation

The REPS 2 & 3 Schemes were launched during this period and the E.U. took direct involvement in the protection of the environmental. In 2006 the 1st EU Nitrates Directive – National Action Programme, (S.I. No.378 of 2006) was introduced in Ireland. The initial version of this legislation would have made it difficult for profitable farming to continue and the authorities in Brussels were heavily canvassed with suggestions and ideas about how the same objectives could be achieved, but using more workable and practical methodologies. The FAI took a scientific view and made a series of submissions to Brussels that were based around the Code of Good Practice. It is fair to say that this lobbying did have some positive effects and when the eventual legislation was put into practice, the new rules and regulations, while somewhat restrictive, were manageable.

The FAI initiated an award scheme in 2000, in which the UCD, Agricultural Science degree student who came first in the soil science examination was given a bursary. Stan Lalor, now actively engaged in the fertiliser industry, was the first recipient of this award. These awards continue to this day. In 2008 the FAI switched its technical meeting from the autumn to spring and also to a more central location in the country. This was an instant success with a larger attendance, comprising mainly of trade and the farming community. The spring date (February) and venue was a much more attractive as it coincided with the start of the fertiliser spreading season when the subject was fresh in everybody's minds. A random example of the scientific presentations during this era were *Blending and spreading fertilizer-physical properties* by Brendan Barnes (IFMA) and Tony Fortune (Oakpark), *Cutting back on fertilisers in 2007* by James Humphreys (Moorepark), *Nutrient regulations, cross compliance and derogations* by Jack Nolan and Al Grogan (Department of Agriculture and Food). There were other papers by Mark Plunkett, Dermot Forrestal and Bernard Rice (Teagasc).

2009 to 2018 – supporting sustainable nutrient management on farms

In 2009 the “Crops Nutrient Management Course” was introduced for agronomists, advisors and technical personnel in the trade and agri-cooperatives. This course is spearheaded by Mark Plunkett and facilitated by Teagasc at Johnstown Castle, Kildalton and Oakpark in conjunction with the FAI. This covers all aspects of crop nutrition from the soil as the medium for crop growth to end product, be it grass, cereal, root crops or vegetables. Additionally this course covers nutrient management planning and is continually updated in-line with Nitrate Regulations as they are adjusted every four years. It provides participants with both the scientific theory and practical application of best practice in soils and nutrient management. In 2017 an additional ½ day practical field module on soil identification and classification was added. Those who successfully complete the Crops Nutrient Management Course receive a QQI 6 FETAC certificate and also

IASIS training points. To date over 300 participants have successfully completed the course and the high demand annually for places is testament to the quality of the course.

Over this decade there were three reviews and updates of the Nitrate Regulations in accordance with EU requirements; 2010; 2014; and 2017. Through its environment sub-committee the FAI made submissions on each occasion as part of the public consultation process set out by Department of Agriculture, Food and the Marine and Department of the Environment. The changes put forward in each FAI submission were based on the best science available and many of the points raised were adopted into the revised regulations. These changes have ensured that Irish farmers can farm in a profitable and environmentally sustainable manner.

The “Nutrient Calculator Wheel” was produced by the FAI in association with Teagasc and K&S UK & Eire Ltd in July 2012 and launched by the Minister of Agriculture, Food and the Marine on 24th July. The Nutrient Wheel is an in-field ready-reckoner for estimating the P and K offtakes and fertiliser requirements for grassland and tillage crops. It simple and user friendly and relies on operator to select the appropriate stocking rate, concentrate feed usage and target crop yield for the field of farm in question. It also includes useful field notes to guide the operator in relation to soil test results & fertility levels, organic manures, lime, sulphur and magnesium. Through the FAI, the Nutrient Wheel was made freely available to advisors, consultants, industry representatives and farmers and fulfils the FAI objectives to increase the efficiency and maximise returns from fertiliser inputs while protecting the environment. In 2013 an online version and in 2016 a mobile phone App was made available and is freely available by following the link to “ P & K Calculator” on the FAI website (www.fertilizer-assoc.ie). This has further facilitated the use of this nutrient management tool by advisor and farmer in the field.

The FAI maintains a modern website which is used extensively by colleges and educational institutions for their students. The FAI has produced 52 Technical Proceeding Booklets over its history and over the past two years the FAI made all these technical papers available on their website. This library is an enormous source of technical and scientific information and the FAI endeavours to make such knowledge available to all.

The FAI’s Spring Scientific Meeting continues to be a great success with large attendances. The central location at Horse & Jockey Co Tipperary is home for this event over the past ten years and the papers continue to be presented by the relevant experts both nationally and internationally. The FAI is indebted to them and indeed to all contributors over the past 50 years. A random sample of the topics covered in recent years are *Grassland management and fertiliser use on intensive dairy farms* by Brendan Horan (Moorepark), *Nutrient use efficiency* by Catherine

Watson and Ronnie Laughin (Belfast), and *The Importance of potassium in soils and plants* by Johnny Johnston (Rothamsted).

In 2015 the FAI initiated a series of “Technical Bulletins” with three such bulletins produced to date and fourth planned for 2018. They are as follows;

- No. 1. (2015): Soil Sampling - why & how.
- No. 2, (2016): Soil pH & Lime.
- No. 3, (2017): Precise Application of Fertilizers.

This is an ongoing project and it is hoped to produce a comprehensive series of technical bulletins covering all aspects of nutrient management and fertiliser use over time.

In recent years the FAI have organised study tours abroad to places of interest concerning agriculture. Some of the places visited were the potash mines in Germany, farms in Poland and France, Rothamsted Research in the UK and CAFRE Greenmount Campus in Northern Ireland.

Conclusions

The FAI is now in existence for 50 years. In that time, it has fulfilled the wishes and objectives of its founding fathers. Over these years, respective FAI council’s can be justifiably proud of their achievements. It is an association with a reputation for hard work, truth and balance. It has helped to establish a strong fertiliser industry at the heart of the agricultural sector in Ireland and has helped to ensure that the farming community are fully conversant with the sustainable use of fertilisers. The importance of the FAI over the past 50 years was highlighted in the recent Ear to the Ground magazine article (December 2017). However, the association must be proactive in facing the challenges of the agricultural sector in the future, such as dwindling mined nutrient and oil resources, improving water quality, meeting greenhouse gas and ammonia emission targets and the effects of climate change. There remains much work to be done going forward for FAI given that, at present, national soil test results indicate that just 11% of soils have good overall fertility in terms of pH, P and K levels. The nutrition of our soils will need to improve if we are to achieve the Food Wise 2025 Agri sector targets and to maintain a future in farming for the next generation.

Table 1. Fertilizer Association of Ireland (FAI) Past Presidents

NAME	YEAR	COMPANY/ ORGANISATION
Dr T Walsh	1968	An Foras Taluntais
WJC Milne	1969	Gouldings
G Foley	1970	CAO, Co. Meath
Dr J N Greene	1971	NFA/IFA
E J Sheehy	1972	Dept. of Agriculture
J C Brogan	1973	Teagasc, Johnstown Castle
Tom James	1974	Limestone Producers
Prof DM McAleese	1975	UCD Chemistry
Seamus McCann	1976	IFA
MI Roche	1977	Albatros
G Cussen	1978	Dept. of Agriculture
W E Murphy (Willie)	1979	Teagasc, Johnstown Castle
Pat McEnroe	1980	Irish Sugar
Tom Fingleton	1981	IFA
John Leonard	1982	Grassland Fertilisers
Pat Duffy	1983	Dept. of Agriculture
Dr MI Ryan	1984	Teagasc, Johnstown Castle
Pat Keane	1985	Golden Vale
Dr JF Collins (Jim)	1986	UCD soils
Merlin Stanley	1987	IFA
W O' Brien (Bill)	1988	IFI
Terry King	1989	IAWS/Gouldings
Gary Leonard	1990	Grassland Fertilisers
Dr TF Gately (Tom)	1991	Teagasc, Johnstown Castle
L T Stafford (Liam)	1992	IFI
R Walsh (Richard)	1993	Teagasc
J Galvin (Jerry)	1994	Dept. of Agriculture
J Murphy (Jeremiah)	1995	McDonogh/Albatros
L Larkin (Liam)	1996	Gouldings
Dr Noel Culleton	1997	Teagasc, Johnstown Castle
Dr P Barry (Paddy)	1998	UCD
B Barnes (Brendan)	1999	IFI
C Watson (Christy)	2000	Teagasc
M Cunningham (Matt)	2001	IFA
P Drennan (Paddy)	2002	Dept. of Agriculture
J Carroll (John)	2003	Glanbia
T Storey (Trevor)	2004	UCD
Dr B Coulter (Brian)	2005 & 2006	Teagasc, Johnstown Castle
J McGrath (John)	2007	Gouldings
T Carroll (Terry)	2008	Teagasc
Dr JJ Fleming (Jim)	2009	Dept. of Agriculture
K Murphy (Kieran)	2010 & 2011	Grassland Fertilisers
Dr STJ Lalor (Stan)	2012 & 2013	Teagasc, Johnstown Castle
P Casey (Paddy)	2014 & 2015	Target Fertilisers
PJ Browne	2016 & 2017	Grassland Agro

How sustainable are Irish dairy farms?

James Humphreys

**Animal and Grassland Research and Innovation Centre,
Teagasc, Moorepark, Fermoy, Co. Cork**

Introduction

The global population has doubled over the last 50 years and is likely to increase by at least the same number (3.5 billion) over the next 50 years. Much of the population growth is due to better sanitation and health care and abundant supplies of cheap food. A key component of ‘green revolution’ over the last 50 years has been Haber-Bosch. It has been estimated that one third of the nitrogen (N) in protein consumed by humans worldwide originated in synthetic fertilizers and this proportion holds true for food produced in Ireland today. It has also been estimated that the capacity to feed the global population without the use of synthetic fertilizers was surpassed during the 1980s. On a global scale there is little economic incentive to bring new land, which is mostly of marginal agricultural potential, into agricultural production and existing agricultural land is being lost to infrastructure and environmental degradation. Coupled with this is growing affluence and demand for higher standards of nutrition and of food safety. Growing affluence leads to exponential consumption of resources with a 60-fold difference in resource consumption between the least and most affluent people on the planet. It is clear that new technologies along with social, economic and political developments over the last century have greatly diminished threats from the four harbingers of the apocalypse: famine, war, plague and pestilence. Optimists maintain that improvements in standards of living and quality of life will continue in future. Pessimists foresee disaster such as pandemics and cataclysmic climate change. Either way there is clearly a need for, and there is a growing focus on sustainable development, greater efficiency of resource use and renewable technologies. In Ireland this is as important for food production as it is for any other sector of the economy. There are also issues such food safety and standards of production, such as antibiotic use and animal welfare, which are of increasing concern for consumers.

From the perspective of the companies who process milk and manufacture dairy products, the key question is whether farmers will remain in business and continue to supply milk of an acceptable standard in the future. Long-term investment decisions are based on such assessments. Dairy farm economic viability is clearly an important aspect. Societal requirements in terms of compliance with legislation for the protection of the environment and animal welfare are also important aspects. Recently we have seen the capping of the size of Dutch dairy herd to comply with regulations governing the national P balance. Although the intensity

of milk output per ha in Ireland is less than one third of that in the Netherlands, it demonstrates the increasing pressures on farmers in an increasingly crowded world.

Sustainable milk production in Ireland

Pasture-based production of milk and milk products have historically occupied a significant economic and cultural position in Ireland and are a major contributor to the national economy. It has had a major influence on land use, on the shaping of our landscapes and on the quality of the water in our rivers and lakes; the ecological status of Irish rivers and lakes are ranked sixth of the EU27 and amongst the highest worldwide. Aspects of milk quality such as somatic cells, antibiotics and other residues, and traceability are strictly controlled under national regulations and industry standards. Best practices are encouraged by a well-established Sustainable Dairy Assurance Scheme (SDAS) and milk quality awards.

How do we compare?

The typical Irish pasture-based system of milk production is a relatively low cost system and typical, established, well managed Irish dairy farms are competitive internationally generating incomes that compare favourably with counterparts in the EU and other developed countries. Furthermore average dairy farm incomes have exceeded the average industrial wage (€35,000 to €45,000) in Ireland in all years over the past decade except 2009 although there are differences in hours worked per week and working conditions. Nevertheless dairy farm incomes must be interpreted in the context that average incomes in Ireland are among the highest worldwide. The level of borrowing on Irish dairy farms (approximately €102,050 in 2016) is low relative to asset value and compared with counterparts in Western Europe and New Zealand. Although the purchase price of land and land rental are relatively expensive in Ireland this hasn't proven to be an obstacle to the successful transition of new entrants to dairying from other farm enterprises and to the recent rapid expansion of milk production in Ireland.

Survey results have shown that in general Irish dairy farmers are reasonably satisfied with their position in society with a substantially better self-image than dairy farmers in France and Spain and more in line with dairy farmers in the Benelux countries. Heavy workloads and long working hours in spring are a major complaint of Irish dairy farmers and they differ in this regard from EU counterparts. The big divergence in workload between the first half and second half of the year is one aspect of our seasonal low cost system that might prove increasingly challenging in future.

Across the EU, and in most countries worldwide, the trend is towards indoor systems of dairy production, whereas there is a growing societal pressure, particularly in the EU, to reverse this trend. There is a lot of evidence to show that

cows prefer to be outside on pasture. Research has shown that cows are less stressed and more comfortable when they are at pasture because they are freer from competition and bullying and likely to spend longer lying down when outside, even under winter conditions grazing crops of kale. The sustainable image of Irish dairy products is underpinned at farm level by grazing cows in a clean environment.

Nutrient use efficiency

Pasture-based production on permanent grassland is a key contributor to the generally low nutrient contamination of Irish rivers and lakes. Nevertheless, P use in particular can have a negative impact on water quality and efficient use of P is important because of diminishing global reserves and increasing cost. High reliance on grazed grass and a low proportion of concentrate in the diet of dairy cows in Ireland is a key contributor to Irish dairy farms having the highest P use efficiency in the world (Figure 1), which is in sharp contrast to the situation in most other EU countries and even Northern Ireland, where concentrate inputs are higher. There have been substantial improvements in slurry storage and slurry and dirty water management on Irish farms over the past decade. Paradoxically, soil deficiencies of lime, P and K have been identified as a key area for improvement because of their impact on grass growth and the economic performance of farms.

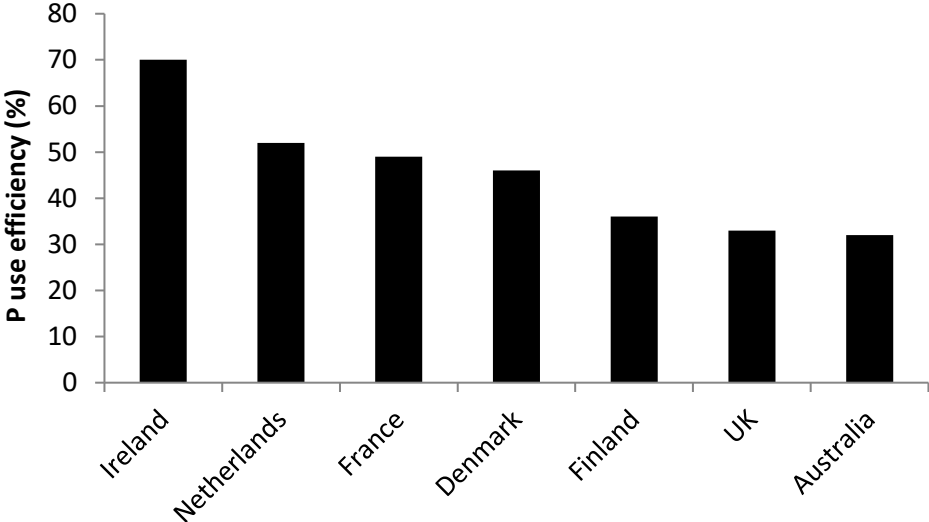


Figure 1. P use efficiency (the ratio of P inputs to a farm that end up in products sold off the farm) on dairy farms in different countries.

Nitrate losses to water tend to be low under permanent grassland particularly on the heavier textured soils and high rainfall conditions that predominate in Ireland. Nevertheless, there is no room for complacency because the continuation of the nitrates derogation is conditional on improving water quality. Furthermore, nitrogen fertilizer use on Irish dairy farms is higher than most other EU countries including the Netherlands, where there is greater reliance on maize. This is a matter for concern because not only can fertilizer N impact on water quality it also contributes to greenhouse gas and ammonia emissions. Nitrogen use efficiency of Irish dairy farms ranges between 15% and 30%. The majority of the remainder is lost either to water or to the atmosphere with only a small proportion retained in the soil from one year to the next. The proportion of total losses that are lost to water can range between 5 and 45%, with the higher end of this range associated with free-draining sandy soils. Gaseous emissions predominate on heavier textured soils and wet soil conditions that are more typical in Ireland. Under such circumstances a large proportion (c. 50%) is lost as environmentally benign dinitrogen gas, which is the biological reversal of Haber-Bosch in the soil, with plant-available N (nitrate and ammonium) converted to atmospheric N₂. One by-product of this N cycling is nitrous oxide, which is a very potent greenhouse gas (see below) and accounts for between 1% and 10% of N losses. Another is ammonia, which accounts for between 20% and 40% of N losses from Irish dairy farms. The Gothenburg protocol requires reduction in ammonia emissions and, in Ireland, 97% of national emissions originate on farms. While these losses are potentially damaging to the environment they also represent an economic loss to the farm.

Nitrogen use efficiency can be improved on farms by good N management practices such as responsible application of slurry, dirty water and fertilizer N in terms of rates and dates of application, applying slurry using trailing shoe, white clover and new fertilizer N formulations such as NBPT-protected urea. It is clear that there remains a large potential for improvement in N use efficiency through better management practices and newly emerging technologies.

Carbon footprint of Irish dairy

It is well known that Irish milk has one of the lowest carbon footprints in the world and certainly one of the lowest in the EU. It offers a unique selling proposition in that a food manufacturer aiming to lower the carbon footprint of its product is likely to favour Irish raw material over that produced on Dutch, French or German farms (particularly when the Irish product is also cost competitive) because over 70% of the carbon footprint of many dairy products is generated within the farm gate. It can also be argued that – from a global perspective – it is better to produce milk on Irish farms rather than in countries with higher emission dairy systems. Relatively low emissions on Irish dairy farms provide justification for expanding national milk output to meet growing international demand. However, these

considerations are not well aligned with current EU policy and international agreements on tackling climate change. In the first place greenhouse gas emissions are accounted for and emission reduction targets are imposed on a national basis. Secondly, Ireland has one of the highest per capita greenhouse emissions in the EU because of our huge reliance on livestock based agriculture and relatively low human population density. Not only do we have a very high per capita economic dependence on agriculture, our main agricultural enterprises, beef and dairy production, are very carbon intensive agricultural land uses compared with alternatives such as arable crops. The challenge for policy makers is how to meet the growing global demand for high quality and safe food while transitioning to a low carbon economy.

Summary and Conclusions

Ireland has an excellent international reputation for safe, high quality and sustainably produced dairy products. This is reflected in Irish products gaining premium status and greater access to markets worldwide. The sustainable image is underpinned at farm level by grass-based production in a clean environment. It is imperative to objectively and credibly verify criteria used to assess dairy farm sustainability to the highest scientific standards. When examined within the context of the three main pillars of sustainability; economic, societal and environmental, Irish farms perform very well generating good incomes for farm families on farms with world-leading phosphorus (P) use efficiency and producing milk with one of the lowest carbon footprints in the world.

Dairy production in Ireland is built on solid sustainable foundations and is proactive in meeting emerging societal requirements for environmental protection and animal welfare. More than ever it is important to protect and foster the sustainable image of our dairy farms.

Soil phosphorus management and water quality in two agricultural catchments

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Introduction

High yielding crops in Ireland are dependent on obtaining balanced and optimum supply of nutrients from the soil. Phosphorus (P) plays a vital role in plants, where it stimulates early plant development and is required in feed and food sources for animals and humans. If the soil P is in limited supply to meet and sustain the demand for optimum plant growth, P rich nutrient sources are usually applied by farmers as mineral fertilizers and/or organic manures and slurries (Cullenton *et al.* 2002).

These P inputs are critical in an arable cropping system where large quantities of P are removed with the harvested crop and there is limited recycling of nutrients back into the soil. In Ireland P usage on farms, has declined within the last two decades (Plunkett and Wall, 2016). This reduction has been linked to the higher costs of mineral P fertilizer coupled with lower milk, meat and grain prices, creating a price – cost squeeze on fertilizer inputs. In implementation P fertilizer limits on farms through Nitrates Directive regulations and agri-environmental schemes has led to reduced P usage on farms (Buckley *et al.*, 2016).

Phosphorus is considered the main limiting nutrient for algal growth in freshwater systems and elevated P concentrations, even relatively small increases, can lead to eutrophication. Therefore P loss from the landscape can contribute to the failure of achievement of good ecological status in water bodies as is required under the European Union's (EU) Water Framework Directive (WFD, 2000/60/EC). Soils that have P levels in excess of the agronomic requirement are typically more vulnerable to P loss in surface runoff and leaching (Regan *et al.* 2012). In Ireland, the soil test P (Morgan's extractable P) concentration is categorized into 4 soil P indices (Index 1 and 2 = deficient, Index 3 = optimum and Index =; High/excessive). These indices are used both as the indicator of P availability to the crop and as an environmental indicator of potential risk of loss to water. Within the Nitrates Directive - National Action Programme (NAP) (SI, 605 of 2017), limits to N and P inputs apply at farm and field scales according to crop, animal and soil nutrient build-up requirements.

The Teagasc Agricultural Catchments Programme (ACP) was established in 2009, to evaluate the environmental and economic effectiveness of the NAP measures in

catchments that represented the main land type and agricultural production systems with medium to high intensities. This is carried out in partnership with the catchment farmers by an integrated advisory and research team. Within each catchment the same study design is implemented whereby nutrients are assessed at farm, soil, groundwater and stream levels (Wall *et al.*, 2011).

Improved farm sustainability is the underlying theme of the ACP, where the twin aims are to improve water quality and support for the production of high quality food. These are aligned with Food Wise 2025 challenges; such as supplying P requirements for agriculture and food production while minimising P losses and their negative impacts in aquatic environments.

Presented here are the outcomes from an ACP study of two catchments of mixed land-use, on contrasting soil types between 2010 and 2014. Changes in P management in the context of soil P, P usage, P off-takes and P balances at field scale were examined. An investigation of the soil properties controlling P availability and possible implications to water quality were also conducted.

Both study catchments are presented in figure 1;

- The Castledockerell catchment is located Co. Wexford, is 11.2 km² on mostly well drained Clonroche type soils. Tillage is the main land-use (61%) dominated by malting spring barley.
- The Dunleer catchment is located in Co. Louth, on poor to moderately drained soils. Grassland is the main land-use (44%), utilized by a mixture of livestock enterprises. Uniquely for the type of soil and associated poor drainage, a high density of tillage (34%) production is carried out, with winter wheat the dominant crop type.

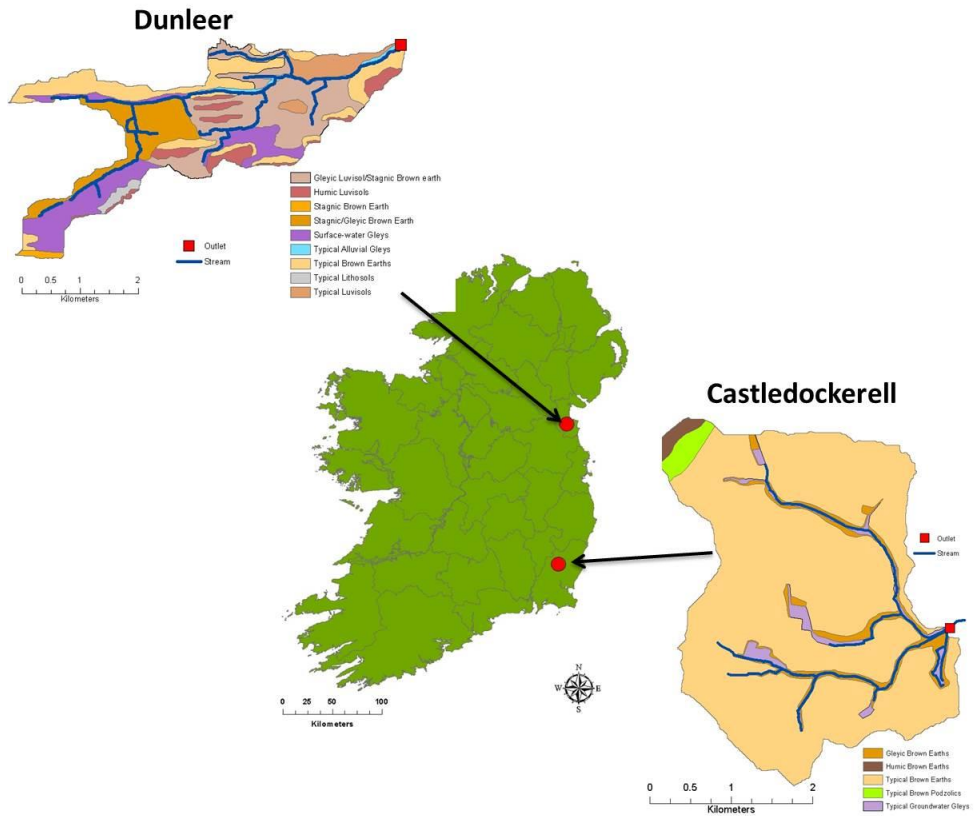


Figure 1. Location and main soil types of the Castledockerell and Dunleer catchments.

Soil P trends

Initially the baseline of soil fertility status of the fields in each catchment was established by soil sampling each field at approximately 2 ha scale. The Castledockerell catchment was first sampled in 2009 and this was repeated in 2013. Over this four year period the percentage area of Index 4 soils (higher risk for P loss to water) reduced by 4% (17% to 13%) however, agronomic optimum (P index 3) also declined by 3% (23 to 20%) with a subsequent increase in the combined area of sub-optimal P index 2 and 1 soils by 7% (60% to 67%) (Figure 2). In contrast, between 2010 and 2014 in Dunleer, the area of index 4 fields increased by 4% (from 22% to 26%), with P index 3 and 2 remaining relatively constant at 17% and 34% respectively, and the area of index 1 soils decreased by 5% (28 to 23%; Figure 2).

A third soil nutrient survey of the Castledockerell in late 2016 found that index 4 soils had reduced to 10% and that the overall decline in soil fertility had ceased as

the percentage of index 3 soils recovered somewhat (23%) while the index 1 soils had declined from 31 to 27%. A third nutrient soil fertility survey of Dunleer fields is currently underway.

With more than 57% of soils in both catchments at sub-optimal level these trends are in line with national soil fertility levels (Plunkett and Wall, 2016). This poses a threat to production potential on farms and to the targets set out in Food Wise 2025 strategy. These trends also highlight an on-going issue with poor nutrient distribution within and between farms and more effort is needed to redirect away P from index 4 fields onto sub-optimal areas at farm and catchment scales.

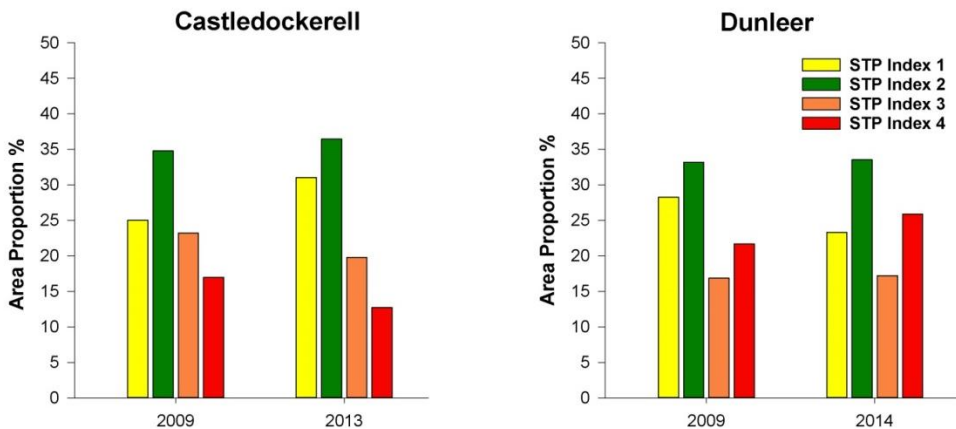


Figure 2. Percentage area of soils falling within each soil P index (1-4) in the Castledockerell and Dunleer catchments between 2009 and 2013-2014.

Fertilizer P usage

Fertilizers (mineral and organic) accounted for the main P inputs to soils in both catchments. In Castledockerell mineral P was the main form of P applied (i.e. 87% of the total), of which 53% was applied in the compound mixture (N-P-K) 10-10-20. Small levels of P were obtained from applications of farmyard manure (FYM), pig and cattle slurry. In Dunleer, 69% of P inputs were from cattle slurry, FYM and some imports of poultry manure and spent mushroom compost. Of the P applied in the mineral form, most was from the two compound mixtures; 10-5-25 and 10-10-20. As presented in table 1, in Castledockerell, the average yearly total fertilizer P (mineral and organic) applied to fields increased from 25 to 32 kg/ha/yr between 2010 and 2013. In comparison the average total P fertilizer inputs in Dunleer fields increased from 23 to 39 kg/ha/yr over the same 4 year period. The increasing trend of P inputs in both catchments is reflective of some farmers responding to low baseline soil P levels and the need to sustain and increase crop yields and grassland

production, especially with new and expanding dairy farms in Dunleer during this period.

Phosphorus off-take and balances at field scale

As shown in table 1 the average P off-takes of crops from both catchments remained relatively similar from 2010 to 2013 (23.9 kg P/ha/yr) with the exception of 2012 where yields suffered as a result very high rainfall. Phosphorus input or removal by grazing livestock within a field was accounted for as the change (decrease/increase) in stocking rate from the previous year (2010 was used as the base year for these calculations). As expected, due to generally low livestock numbers P input from livestock in Castledockerell was low, but in Dunleer the average input of P from grazing livestock increased over this period as some farmers prepared for post milk quota production in 2015.

Table 1: Average P; inputs, off-takes, build-up and field and soil P balances in Castledockerell and Dunleer in 2010-2013

	Castledockerell				Dunleer			
	2010	2011	2012	2013	2010	2011	2012	2013
Phosphorus Inputs	kg/ha/yr							
Total fertilizer P applied	25.0	26.0	28.8	32.2	23.1	33.8	37.5	39.3
Conc. P fed at grazing	2.22	1.09	1.29	1.32	1.61	1.57	1.07	3.39
Phosphorus Off-takes	kg/ha/yr							
Crop P off-take	23.1	24.0	23.3	25.1	24.5	25.3	21.7	24.2
Stocking rate change		-1.2	1.0	0.5		2.7	1.2	3.0
Soil P Build-up required	8.7	8.6	8.6	8.6	9.7	9.5	9.8	9.4
Phosphorus Balances	kg/ha/yr							
P balance	2.7	1.9	6.1	7.5	-0.6	13.9	19.0	25.5
Soil P balance	-6.1	-6.7	-2.5	-1.1	-10	4.4	9.2	16.1

The field P balances were calculated by subtracting the total P off-takes from the total P inputs for each field in each year as shown in figure 3. The optimal soil P balances were calculated by subtracting the total P off-takes plus the soil P build-up requirement (20 kg/ha for index 1 and 10 kg/ha for index 2) from the total P inputs for each field.

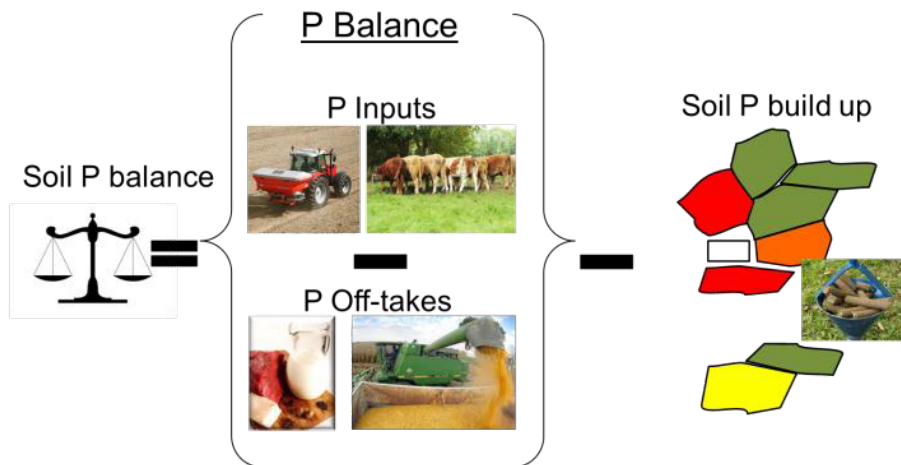


Figure 3. Calculation of field P balance and soil P balances

When the field and soil P balances for the main crop types across both catchments were calculated (figure 4), the largest average field P balance and soil P balance 73.3 kg/ha/yr and 59.7 kg/ha/yr respectively, were for fields with maize crops. The lowest average field and soil P balances of -14.6 kg/ha/yr and -43.1 kg/ha/yr, respectively, were on field used solely for grass silage production. In general, high value and short duration crops such as maize and root crops had higher P inputs as they require rapid root and tuber development once germinated and the agronomic P recommendations for these crops can be greater than the final P removed by the crop in that season (Wall and Plunkett, 2016). Overall these results show that crop type can have a large impact on the levels of P applied, retained, removed and recycled to the soil. However, while average values for each crop type are shown there was often large variability in P management within crop types.

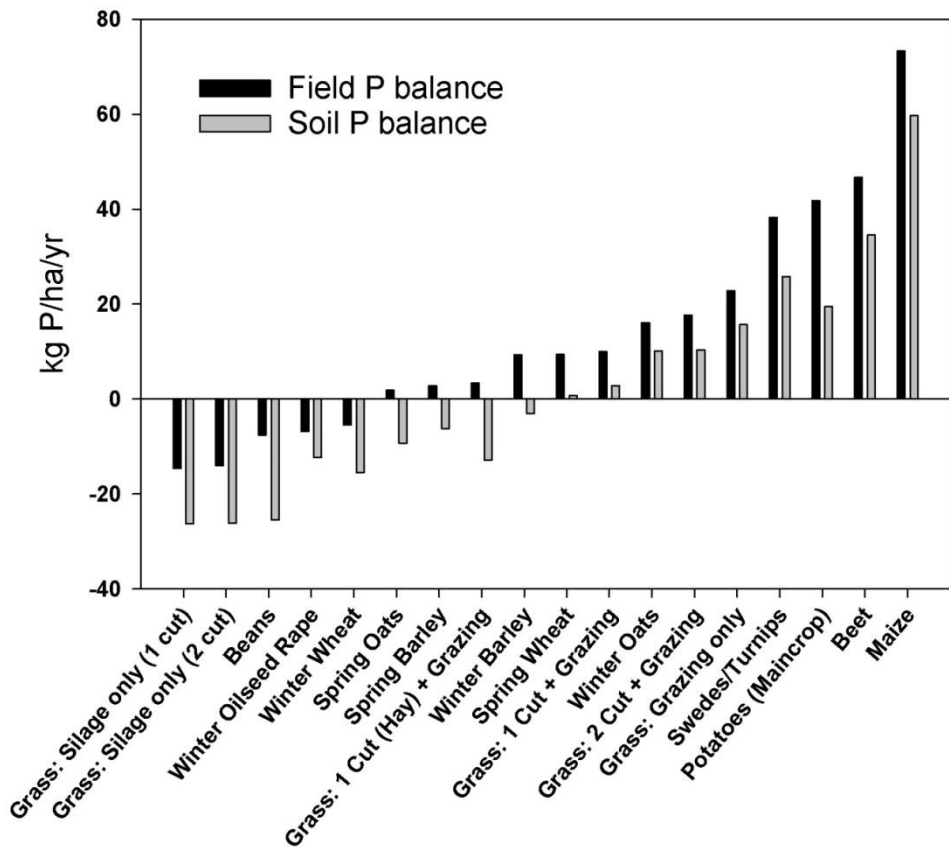


Figure 4. Average field and soil P balances per dominant crop type across the study period (2010-2013) for both catchments combined.

Influence of soil chemistry on P supply

Available P extracted in soil tests is <1% of the total P in the soil. The soil test estimates the available P that will be released from the soil for plant uptake (Sheil at al. 2015). This P availability from the soil to the plant can be impacted by the soil pH and prevalence of the soil elements such as aluminium (Al), iron (Fe) and calcium (Ca). The lower the soil pH (<6.0) the greater the levels of Al and Fe available to bind P and make it unavailable to the plant, while at high pH levels (>7.0) available P can be precipitated as Ca-P with is also unavailable for plant uptake.

In Ireland the soil test P is a standard and reliable indicator of P availability for crops, however, since the introduction of the Nitrates Directive NAP it is also used as an indicator of environmental risk and used as a basis for maximum P fertilizer limits. Irish soils vary in their P binding and fixation capacities due to their contrasting parent material and chemical properties. However, the current P

management advice is similar across all mineral soil types, and does not account for soil P fixation especially on low P fertility soils (i.e. P index 1 and 2 soils). Within these situations as P is applied it is quickly sorbed like a sponge until after repeated applications of P fertilizer it becomes increasingly saturated, after which any additional P applied is more freely available.

The likelihood of a soil to sorb or supply P can be measured by the degree of P saturation (DPS, calculated as ratio of P to Al+Fe extracted by Mehlich-3 solution). From a sub-set of fields, sampled across each catchment, the water soluble P (WSP) and the DPS were determined (Wall *et al.*, 2012). Figure 5 shows the relationship between WSP and the DPS for the soils within each catchment. Two things can be observed from this graph; 1) that WSP increased as the DPS increased in both catchments and 2) as the DPS went above 20% (represented by the green dotted line), the level of P that is extracted by water (i.e. WSP) increases exponentially within the Dunleer soils, but not in the Castledockerell soils. This shows that the soils from each of these catchments have different thresholds of P saturation to reach a given WSP level (> 3 mg/L). This indicates that these soils will behave differently in response to P applications and that different P fertilizer management strategies should be implemented in each catchment area. The Castledockerell soils have a greater capacity to bind P and mitigate P loss, but these soils may take longer to build-up to target agronomic soil test P levels (index 3) compared to Dunleer soils which have been shown to build-up much faster.

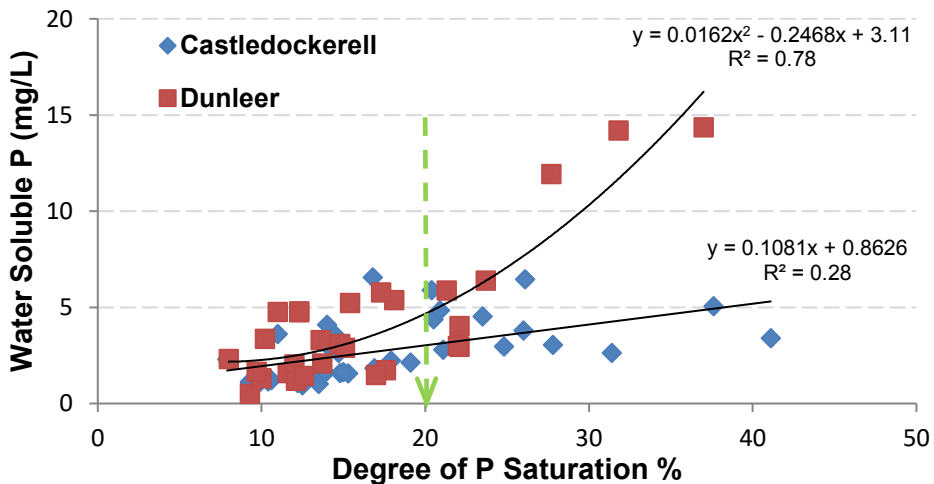


Figure 5. Relationship between water soluble P and the degree of P saturation for soils in Castledockerell (blue diamonds) and Dunleer (red squares) catchments.

Implications for water quality

The concentrations of P in the form of total reactive P (TRP) and total P (TP), discharged at the outlet of each catchment (see figure 1) have been monitored at a sub-hourly basis since 2010. A measure of good water quality status as be defined by the Irish Environmental Quality Standard (EQS) is $\leq 0.035\text{mg/l}$ of TRP. The total P relates to all P, including that bound to sediment and clay particulates which can be suspended in the water.

Figure 6 provides a summary of the average yearly concentrations of both TRP and TP between 2010 and 2013. The results show that in Castledockerell the concentrations of TRP (represented by the dotted line) were lower than the EQS (red line) on an annual basis with indications of declining TRP levels towards the end of this period. However, in Dunleer the TRP concentrations consistently exceeded the EQS. There is no standard for TP concentrations (represented by the black line) however, the TP concentration were on average four times higher in Dunleer compared to Castledcokerell between 2010 and 2013. In 2012 the TP concentrations in both catchments increased due to the high rainfall, indicating the more sediment bound P may have been lost from the wet soils.

As P concentrations are measured on a high temporal resolution, the water quality measurements encompasses periods of low and high stream flow. During period of low flow it is less likely the P in the stream is coming directly from the soil or field surface (known as diffuse P loss). However, these diffuse P losses can be amplified by weather and the soil type and hydrology of a catchment (Mellander *et al*, 2018). Observations from within each catchment by Shore *et al.* (2017) show that diffuse P loss from fields and domestic and agricultural point sources are contributors to the annual P loads leaving these catchments in the stream.

These water quality measurements indicate that relatively low levels of P is entering the Castledockerell stream from fields and that, in general, the P management on these fields may not be an issue for water quality. Due to the free draining nature of these soils, this catchment is more vulnerable to nitrogen loss via leaching. In contrast, the Dunleer stream had consistently high levels of P, suggesting that some areas of P management still need to be addressed through better nutrient management practices on these more poorly drained soils.

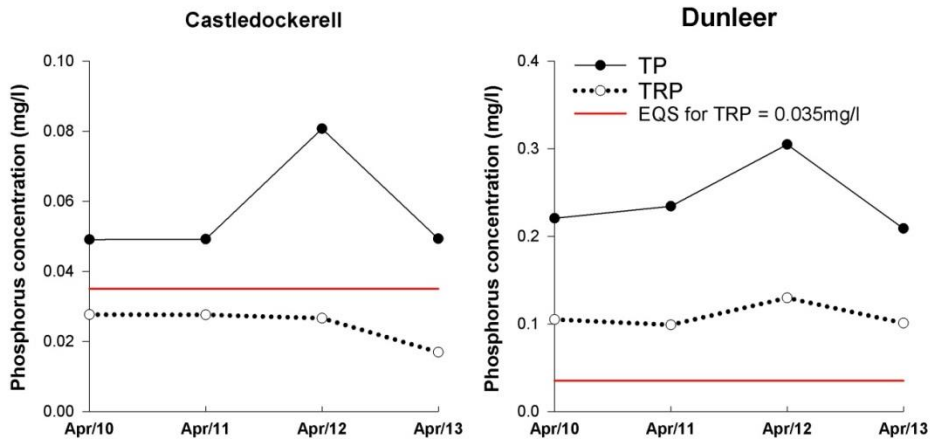


Figure 6. Annual flow-weighted average of total P (TP) and total reactive P (TRP) concentrations at the stream outlets of the Castledockerell and Dunleer Catchments. The environmental quality standard (EQS) threshold for TRP levels is illustrated by a red line.

Conclusions

From this study of soil nutrient levels, farming systems, management practices, and water quality in two agricultural catchments in Ireland we can draw the following conclusions:

- Phosphorus is a critical resource for agriculture and food production and needs to be used sustainably to protect the production potential of agricultural land and to reduce any negative economic and environmental effects associated with its use.
- Approximately 60% of the area in both catchments had STP levels that were below the agronomic optimum (i.e. index 1 and 2).
- The average nutrient P inputs per ha increased over the study period resulting in positive field P balances in both catchments.
- The area of each catchment with high P status and higher P loss risk potential (i.e. P index 4) declined in Castledockerell over the study period, but increased in Dunleer.
- Within the Castledockerell catchment, the average P balances increased due to increasing mineral P applications, however, these P fertilizer inputs did not fulfil the P build-up requirements of the soils across this catchment.
- Within the Dunleer catchment, the average P balances increased due to nutrient P inputs from organic sources i.e. cattle slurries and manures as a

result of increased stocking rates and P from imported poultry and mushroom manures.

- The distribution of P fertilizers within farms was sometimes poor and P inputs often did not match crop and soil P requirements at the field scale.
- Crop type and its utilization (e.g. grazing vs. silage) had a large influence on the levels of P applied, retained, removed and recycled to the soil.
- Soil type differences (soil chemical properties) affect the storage of P and its mobility, and the Castledockerell soils had a much higher capacity to store and buffer against P loss compared to Dunleer soils.
- Reducing P losses from landscapes with legacy soil P is challenging, especially combined with factors such as weather, soil type, hydrology and point sources (industrial, domestic and agricultural) that can also influence P losses to water.
- Within both catchments improvement of P management to address agronomic and water quality issues is on-going. Soil and catchment specific nutrient advice could help to achieve better agronomic and environmental outcomes on Irish farms.

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Beef farming on low fertility soils.

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Introduction

My name is Paul Delaney, I am married to Maria and we have one son. I farm approximately 3 kilometres from Portlaoise town. I farm 81 ha of land of which 34.5 ha is owned, 12.5 ha is on long term lease, and 34 ha is rented. We run beef and tillage enterprises. The beef enterprise is run on 43 ha of grassland and comprises of 50 single suckler cows with all progeny taken to beef. In addition another 90 weanling bulls are bought-in and finished as bull beef. In the tillage enterprise I grow 30 ha of spring barley and 8 ha of winter wheat. The land I farm is predominantly good quality well drained mineral soils, the grassland is mainly old permanent pasture with only 10 ha reseeded in the last two years. I can grow sufficient quantities of grass early in the year and achieve an early turnout.

Beef Farming System

The suckler herd calves in spring with an average calving date of March 9th, so it is essential that I have early grass for a quick turnout after calving. The herd comprises mainly Simmental X British Friesian cows. I am very happy with the output achieved of 0.94 calves per cow per year compared to a national average of 0.85. I aim to finish all bulls under 16 months, last year bulls were on average 17 months of age at slaughter with average carcass weight of 411 kg's, heifers were slaughtered at 20 months at a carcass weight of 333 kg's.

Grassland

Grass is a very important driver of output and profit on my farm. The grassland is divided up into 38 paddocks with average area just over 1 ha. I aim to graze out paddocks within two days. I began grass measuring in 2016 and hope to record covers more frequently in future years. Last year cattle were turned out in mid-March and stayed at grass for 250 days. My grassland stocking rate in 2017 was 2.8 livestock units/ha, having applied 156 kg/ha of Nitrogen (N) and 20 kg/ha of phosphorus (P), and 50 kg/ha of potassium (K). I spread fertilizer on average twice a week with most paddocks getting 5-6 applications over the growing season. My first fertilizer application is half a bag of Urea per acre followed by 5 applications of a compound fertilizer. This is typical of the fertiliser programme for the entire grassland area of the farm in 2017, including the leased land for which I will provide more detail later.

The overall fertility of the farm, grassland and tillage is shown in figure 1. Approximately two thirds of the farm has up to date soil tests and I intend to soil sample the remainder of the grassland area this spring. Some of the older samples were high in P (index 4) and I believe that the soil P fertility has declined in these fields since the last soil samples were taken. In the soil fertility summary for the farm (figure 1) the area showing high P is based on historic samples, which for Nitrate’s planning regulations must still be declared as high P until up to date samples indicate otherwise. Following recent soil sampling of the other areas within the farm, no samples showed up index 4 for P, therefore it is essential that I resample the historic P index 4 land .

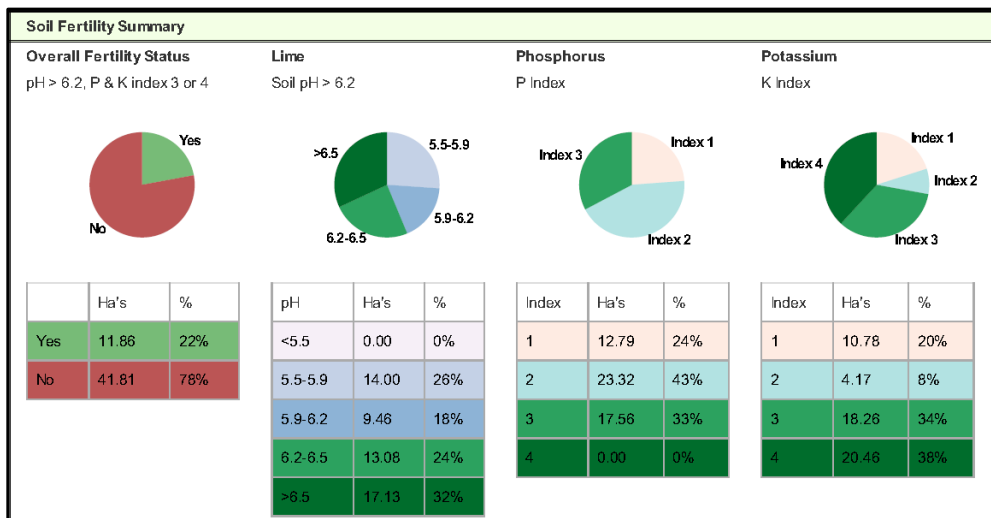


Figure 1. Summary of soil fertility on the Delaney beef farm, showing the proportion of soils with good overall soil fertility status, and the proportions of soils within the soil fertility index ranges for lime, phosphorus and potassium.

On the home farm soil K levels are quite good with all fields at K index 3, on the leased land two thirds of the samples are at index 1 for K. Regarding P, again there is a very different picture on the home farm compared to the leased farm at Rathevan. The entire home farm is at P index 3 while the Rathevan farm has very low soil P levels (P index 1). I am a great believer in the value of sulphur (S) and on both tillage and grassland all compound fertilizers applied contain S.

Average soil pH is reasonably good on the farm and in autumn 2016 approximately 90 tonnes of lime was applied on the farm in order to sort out any remaining soil acidity issues. Across the whole farm, both tillage and grassland, I am using about 90% of my P fertiliser allowance and 60% of my N fertiliser allowance. In 2017, it was estimated that 10.3 tonnes grass dry matter per hectare was utilised. I’m quite

happy with this level of grass utilisation; bearing in mind my grassland is predominantly old pasture.

Low fertility on leased land – the Rathevan farm

In late 2015 I leased 12.5 ha of grassland, including a farmyard, the Rathevan farm, which is located 3 kilometres from the home farm. This land block suited me due to its relatively close location and the cattle housing facilities present. This land had been rented out for many years and was in poor condition. I soil sampled this farm in Autumn 2015 and was not surprised to find that low soil fertility was a major issue, and would need to be addressed.

Table 1. Soil test results for 3 soil samples taken from the Rathevan farm showing the soil pH, P and K levels (mg/L).

Nutrients Test Results				Laboratory Results (mg/l)			
Set/Code	Ident	Field/NMP	Crop	pH	P	K	
	IAH/983-(3)	R1	Good Permanent Grass (GG)	6.53	2.26	82.40	
	IAH/984-(3)	R2	Good Permanent Grass (GG)	5.84	1.65	151.00	
	IAH/985-(3)	R3	Good Permanent Grass (GG)	6.47	2.44	35.90	

Soil test results for the Rathevan farm are shown in Table 1. All three samples were very low in P (index 1), and two samples were very low in K. The farm was generally ok for lime, with only one sample requiring lime to correct soil acidity. With these soil test results I got extremely valuable soil fertility information for this leased land. Armed with this evidence I prepared a plan of action with the aim of growing and utilising as much grass as possible from this land block.

Paddock grazing system

Because of my experience working with old permanent pasture and not wanting to invest up to €300 per acre in reseeding in such a low fertility situation I decided to try and manage my way out of this dilemma. Therefore I plan to reseed this land after I have improved the soil fertility and increased my stock numbers. However, in the short term my priority was to get it up and running and generating money. In early 2016 I divided the 12.5 ha into 14 paddock divisions (average paddock size 0.87ha or 2.0 acres), this layout is shown in figure 2. There was an old central roadway on the farm and this dictated paddock layout and this land was divided into with 8 paddocks one side of the roadway and 6 on the other. With both bulls and heifers at grass the central roadway allowed me to put some distance between these groups. Following turnout to grass in spring the bulls start the rotation in paddock 18 grazing towards paddock 25, and the heifers start in paddock 26 and

containing higher levels of P and K compared to what was applied on the home farm, where there is good fertility levels. The amount of fertilizer applied in 2017 on the Rathevan farm is shown in table 2.

Table 2. Fertilizer inputs to the Rathevan farm in 2017.

Fertilizer	Rate bags/ha (ac)	Nutrients applied kg/ha (units/ac)			
		N	P	K	S
Urea	1.25 (0.5)	29(23)	-	-	-
18-6-12+S	12.4 (5.0)	113(90)	37.5(30)	75(60)	25(20)
Annual Total		142(113)	37.5(30)	75(60)	25(20)

Farm Performance 2017

The livestock carried on the Rathevan farm from mid-March to early November is shown in Table 3. On March 13th I turned out 40 yearling bulls (average weight 420 kg's) and 28 yearling heifers (average weight 390 kg's) along with two Suckler cows (to be culled) and calves, this gave a total stocking rate of 2,400 kg/ha live weight or almost one tonne of beef live weight per acre. The bulls were housed on August 24th and put on *ad-lib* meal to finish. In early September 31 weanling bulls averaging 384 kg's live weight were brought on to the Rathevan farm and 23 weanling heifers were introduced on October 1st. Nine heifers and 1 cull cow were slaughtered off this farm in the middle of September. All livestock were removed from Rathevan on November 1st.

Table 3. Livestock type and numbers at grazing on the Rathevan farm during 2017.

<u>Stock type</u>	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr Av.
Suckler Cow	0	0	1	2	2	2	2	2	1	1	0		1.1
1-2yr Cattle	0	0	34	68	68	68	68	59	31	26	0	0	35.2
0-1yr Cattle	0	0	1	2	2	2	2	2	33	41	0	0	7.0

During the grazing season 60 round bales of surplus grass, as silage, were removed from the Rathevan farm. When the grass grazed by the livestock and baled silage produced are considered together, I estimate that approximately 11 tonnes of grass dry matter per hectare were utilised over the grazing season on the Rathevan farm. As a livestock farmer, animal output is a critical driver of farm profitability. I estimate over the 240 grazing days the Rathevan block of land produced approximately 9,000 kg's of animal live weight. If valued @ €2.35/kg LW this works out at a total output value of €21,150, plus the market value of 60 round bales of silage of €1,500 to give a total output value for 2017 of almost €23,000 or

€1,840/ha. My fertilizer cost per ha on the Rathevan farm was €225 which includes the cost of fertility maintenance and build-up. On the home farm fertilizer costs were lower at €188 per ha as these soils are at index 3 and no build-up was necessary. Therefore on the Rathevan low fertility soils I spent 20% more on fertilizer or an additional €37/ha compared to the home farm. If I had re-seeded Rathevan in 2016, I would have invested almost €750 per ha and I would still have a low fertility farm. However, by correcting soil fertility and implementing paddock grazing first, I am getting an immediate return on a much lower initial investment.

General reflections

Overall I am very happy with the output I am getting from this block of land that has not been reseeded in years and suffers from very low soil fertility. I am convinced with paddock grazing and appropriate lime and fertilizer applications, that even old pastures can make a major contribution to farm output and profitability. In future I intend to reseed some of this land when in conjunction with increasing stock numbers once I observe grass production running tight. These pastures look very good at the moment and I can see a remarkable improvement after just two years with very little capital expenditure, tight grazing management and appropriate fertilizer and lime applications.

FERTILIZER ASSOCIATION OF IRELAND

2017 Council Members

<u>Name</u>	<u>Role</u>	<u>Organisation</u>
P J Browne	President	Grassland Agro
Peter Ging	Vice-President	Gouldings
Jeremiah Murphy	Secretary	Target
Tim Sheil	Treasurer	Bolgers Agri
Eoin O Carroll	PRO	Lime Association
Paddy Casey	Past-President	John Grennan/Target
John Carroll	Council	Glanbia
David Wall	Council	Teagasc
Mark Plunkett	Council	Teagasc
John Corr	Council	DAFM
Enda McDonald	Council	Grassland Agro
Thomas Cooney	Council	IFA
John McGrath	Council	Gouldings
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