



Ruminant grassland production systems in Ireland

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Abstract

In Ireland grazing systems provide the basis of sustainable livestock production, as grazed grass is the cheapest feed source of nutrients for ruminants. The main future objective for these systems is to achieve high grass utilisation, ensure system sustainability and maintain extremely high animal health and welfare. There is no reason why all three cannot be combined. Ireland's national farm policy targets growth in exports to €19 billion per annum by 2025. This figure represents an 85% increase from the current 3 yr average. There are major improvements required in the areas of grassland management and its conversion into milk and meat to fulfil such a target. While every farm situation is unique due to varying soil types, climatic conditions, stocking rates and management capabilities, herbage production and utilisation is below optimum on most farms. Irish farms, especially dairy farms, are expanding and will continue to do so over the next number of years. Increasing stocking rates and more compact calving and lambing has resulted in increased spring feed demand. Extra grass needs to be grown and utilised in this period to minimise the use of supplementary feed. This paper outlines the importance of grassland on Irish farms, and where farms can improve grassland management, to increase output, lower farm costs and improve further farm system sustainability.

Keywords

Grassland • grazing • ruminant production • sustainability

Introduction

Grasslands contribute substantially to Irish agricultural production systems providing a large proportion of the feed requirements of ruminant livestock (O'Mara, 2008). Grassland in Ireland accounts for approximately 92% (3.91 million hectares [ha]) of the agricultural land area (CSO, 2017) (Table 1). Rough grazing includes grazed unreclaimable bogland, and grazed mountain and lowland partially covered in scrub, bushes or rock (O'Mara, 2008). The average proportion of the total grass silage area (1.066 million ha) harvested for first, second and subsequent silage harvests is 78%, 21% and 1%, respectively (O'Donovan *et al.*, 2011). The use of other crops, such as maize silage and beet, has declined in recent years. Irish grassland can produce some of the highest non-irrigated herbage yields (12–16 t dry matter (DM)/ha per annum) in Europe (O'Donovan *et al.*, 2011).

Table 2 shows livestock numbers in Ireland for the period 2013–2017. Total cattle numbers have increased by 461,000 head. The substantial increase in this number has

been generated from the increase in dairy cows (+269,000); suckler cows numbers have decreased (–69,000) in the same period. Increases in younger stock have taken place in line with the maternal increases of dairy cows. Total sheep numbers have increased by 245,900 in the period; however, the number of breeding ewes has declined by 57,000, which shows an increase in the efficiency of the sheep flock.

The increase in dairy cow numbers has been greatest in the South East and West of the country, which have seen the largest regional increases (+70,000 each); the Western and Border regions have recorded the least increase, 11,000 and 17,000, respectively. The largest reduction in suckler cow numbers has occurred in the South East (–15,000), while suckler cow numbers in the West of Ireland have remained largely the same. In the future, it is likely that suckler cow numbers will decline further, and in 2017 the number of suckler cows calved declined by 3%.

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Table 1: Area farmed ('000 ha) by type of land use and year (2013–2017)

	2013	2014	2015	2016	2017
Area farmed (AAU ¹)	4,477.8	4,465.8	4,429.5	4,447.2	4,489.5
Crops and pasture	4,004.3	3,971.5	3,926.0	3,914.8	3,969.3
Pasture	2,337.7	2,308.4	2,299.4	2,307.8	2,322.7
Hay	218.4	217.9	195.7	188.4	192.1
Grass silage	1,071.0	1,077.6	1,071.1	1,066.8	1,088.9
Maize silage	14.5	13.9	12.9	10.9	11.9
Fodder rape and kale	1.4	1.2	1.7	1.6	1.6
Beet	10.1	10.3	9.6	9.5	10.0
Other crops	4.7	4.0	5.8	7.7	28.1
Total cereals	307.8	306.7	292.4	281.1	272.4
Rough grazing in use	473.5	494.2	503.6	532.4	520.2

¹AAU = Agricultural Area Utilised. Source: Central Statistics Office (2017).

Table 2: Number of livestock ('000 head) by type of animal and year (2013–2017)

	2013	2014	2015	2016	2017
Total cattle	6,902.6	6,926.1	6,963.5	7,221.2	7,363.5
Cows	2,313.5	2,355.4	2,371.6	2,501.6	2,513.6
Dairy cows	1,163.2	1,226.4	1,295.8	1,397.9	1,432.7
Suckler cows	1,150.3	1,129.0	1,075.8	1,103.7	1,081.0
Bulls	41.4	40.8	36.5	25.0	16.9
Cattle: 2 yr and over	768.3	884.3	808.1	715.5	788.1
Cattle: 1–2 yr	1,811.0	1,767.2	1,705.1	1,853.3	1,913.9
Cattle: under 1 yr	1,968.5	1,878.4	2,042.2	2,125.9	2,130.9
Total sheep	5,007.0	5,096.8	5,138.7	5,179.2	5,252.9
Breeding sheep	2,648.6	2,591.3	2,563.9	2,582.8	2,591.5

Feed costs

Grazed grass is the most efficient feed for grass-based ruminant production systems in Ireland. The relative cost of grazed grass is €75/t utilisable (U) DM compared to first cut grass silage at €185/t UDM, second cut grass silage at €182/t UDM and rolled barley at €188/t UDM (Finneran *et al.*, 2010). Costs were calculated using a stocking rate of 2.5 livestock units (LU)/ha and herbage DM production of 13.5 t DM/ha and a land costs charge of €350/ha (Finneran *et al.*, 2010) and feeds were compared on a UFL basis. The relative competitive advantage of grazed grass is expected to increase over the next number of years due to higher concentrate prices and the high cost of producing conserved

feeds (grass and maize silage; costs include labour, energy and machinery costs).

Industry targets

The progress of the Irish ruminant sector has been assisted greatly by the positive Agriculture Policy of the Irish Department of Agriculture, Food and Marine. Successive Agriculture Policy initiatives such as Food Harvest 2020 and currently Food Wise 2025 (DAFM, 2015) have identified agriculture as a key sector for the growth of the Irish economy. The Food Wise 2025 report (DAFM, 2015) has identified both herbage DM production and utilisation targets for Irish dairy production systems. In 2016 the gross agricultural output

was valued at €6.92 billion (DAFM, 2016). In 2016, dairy and ingredients exports increased by 2% to €3.38 billion. The value of the beef industry to the economy is currently in excess of €2.38 billion. Annual beef output exceeds 535,000 t, of which 90% is exported. Sheep production is a significant contributor to the agricultural economy producing 61,000 t of sheep meat with an output value of €240 million in 2016. This is an increase in value of 4% compared to 2015, with a meat volume output increase of 3%. The 36,313 sheep flocks produce a high-quality product with about 75–80% exported. Since 2010, international markets have accounted for half of the growth in total exports, which reflects the industry's ability to identify and develop new business opportunities. Irish food and drink exports to China have increased six-fold in 6 years, while exports to North America and the rest of Asia have doubled in the same period.

Every 3 yr sectorial enterprise roadmaps (Table 3) are developed for the main ruminant industries (dairy, beef and sheep). These roadmaps are very important targets for the sectors and act as guides to the industry. With the current expansion of the dairy milk pool, systems of milk production in Ireland can become more efficient through increased dairy cow fertility and better grass utilisation, that is, more effective use of home grown feed. There is an expectation of and commitment from the industry to expand in a sustainable manner, which is underpinned by agricultural research in Ireland. In suckler beef production reduced calving interval and increased herbage DM utilisation (more grass in the diet) will together improve the efficiency of the sector. In the sheep sector the key efficiency gains will come from increasing the number of lambs reared per ewe, increasing stocking rate and finally maximising the use of grass and reducing the reliance on supplementary feeds. The common efficiency to be achieved across all sectors is increased grass utilisation.

Farm system sustainability

Farm system sustainability is achieved under the three pillars of economic, social and environmental sustainability. Grass-based systems are more resource efficient as they use home grown feed stuffs and minimise the requirements for purchased feedstuffs and therefore the resources (land, labour, energy, machinery) associated with those feedstuffs. One of the key challenges facing agriculture today in Ireland, and in Europe, is centred on the requirement to reduce environmental losses and impacts. In Ireland and Western Europe, grassland has a high capacity to capture nitrogen (N) as grass is present year-round and grass is actively growing for a large part (10–12 mo) of the year.

Future grass-based milk and meat production systems will need to minimise nutrient losses (e.g. N and phosphorus [P])

Table 3: Dairy, suckler beef and sheep sector roadmaps for current performance, future performance targets up to 2025 and research targets

	Current	2025 target	Current research target 2025
Dairy sector			
Milk delivered (kg/cow)	5,036	5,739	5,800
MS (fat + protein) delivered (kg/cow)	372	448	475
Calving interval (d)	394	385	365
Stocking rate (LU/ha)	1.96	2.15	2.94
Herbage utilised (t DM/ha)	7.36	10.0	12.7
Concentrate per cow (kg)	1,008	750	400
Nitrogen fertiliser (kg N/ha)	176	230	250
GHG emissions (kg CO ₂ e/kg MS)	1.10	0.97	0.83
Suckler beef sector			
Calves/cow per year	0.81	0.85	0.95
Calving interval (d)	407	397	365
Herbage utilised (t DM/ha)	5.6	6.2	11.3
Concentrate per LU (kg)	393	390	298
Nitrogen fertiliser (kg N/ha)	129	145	210
Greenhouse gas emissions (kg CO ₂ e/kg carcass)	25.7	23.5	21.8
Sheep sector			
Lambs weaned/ewe per year	1.29	1.45	1.75
Stocking rate (ewe/ha)	7.3	9	12
Concentrate input (kg/ewe)	90	50	35
Lambs drafted by October 1 (%)	71	70	65
Nitrogen fertiliser (kg N/ha)	69	99	132

Source: Teagasc (2016a).

to water and gaseous emissions (greenhouse gas [GHG], ammonia) to the atmosphere, so that production systems operate in an acceptable way to society as a whole (i.e. good animal welfare, preservation of the ecosystem, landscape, biodiversity). In 2015, nationally N fertiliser application was 129 kg/ha and 39 kg/ha on dairy and beef farms, respectively, and an average of 63 kg N/ha for all agricultural enterprises including tillage (Wall & Dillon, 2017). Inputs of P fertiliser were 4 kg/ha and 9 kg/ha and potassium (K) fertiliser were 9 kg/ha and 21 kg/ha for beef and dairy farms, respectively, in 2015;

these levels of P and K are not adequate for maintenance levels. There has been a continual decline in fertiliser N input since 2005 (average 82 kg/ha) to date. From this analysis it is clear that Irish livestock farms are low chemical fertiliser input systems and in fact are not applying enough P and K to maintain adequate fertility levels. Soil pH levels are well off the requirements for even reasonable levels of grassland output. The most recent research (O'Brien *et al.*, 2017) shows that on National Farm Survey (NFS) farms, the average carbon footprint of milk from Irish farms decreased from 1.17 to 1.04 of carbon dioxide (CO₂)-equivalent/kg of fat and protein corrected milk from 2013 to 2015. This reduction in the average footprint was largely due to an increase in milk solids (MS) yield per ha and a decline in concentrate feeding. This led to a reduction in animal enteric methane emissions, and CO₂ and nitrous oxide emissions from feed production.

On farm N use efficiency (NUE) can be improved substantially. Recent Teagasc National Farm Survey (NFS) reports have shown that NUE is, on average, approximately 25% (Buckley *et al.*, 2019). Some of this lower NUE is due to high levels of concentrate feeding and low MS levels produced from farms. Recent research work from McAuliffe (2020) has shown NUE closer to 40% as a result of the inclusion of white clover in grazed swards and higher MS output per ha from grass-white clover systems compared to grass-only swards combined with low concentrate supplementation levels. Increased white clover inclusion is important to increase NUE on Irish farms in the future, as are better slurry management and the use of low emission slurry systems. Improving NUE will come from a number of combined sources, better fertiliser use, reducing N surplus, better slurry usage, the use of grass white clover swards, lower concentrate usage and the use of lower crude protein concentrates at pasture.

The production system must be profitable, afford a good work-life balance with family life and provide a good working environment for the farmers and any staff that are directly employed in the business.

Increased demand for grass on farms

Major improvements are required in grazing management and the conversion of grass into milk and meat products. While every farm situation is unique with varying soil types, local climatic conditions, stocking rates and farmer management capabilities, herbage DM production is below optimum on most farms. Irish dairy farms have expanded rapidly over the last number of years; average herd size is now approximately 82 cows per farm. Increased herd size requires additional herbage supply (i.e. grass growth) to meet an increasing herd demand. Increasing stocking rates (an additional 100,000 cows calved in spring 2016; ICBF, 2016) and compactness of calving (a reduction in mean calving date of 5 d and an improvement in 6-wk calving rate of 6% from 2011 to 2015; ICBF, 2016) (Figure 1) has increased spring feed demand on dairy farms. Increases in ewe stocking rate (+4%) and weaning rate (+8%) and a resultant increase in carcass output per ha (+15%) relative to the 5 yr average, as shown in Table 4, is also increasing the demand for grass on Irish sheep farms. Extra grass must be grown and utilised in spring to avoid increases in supplementary feed use. It is clear from financial evaluations via Teagasc profit monitor results that farms targeting high levels of grass utilisation are more profitable (+€171/ha, higher net profit dairy farms, +€105/ha on drystock farms) compared to farmers with poorer levels of grass utilisation. Higher levels of supplementary feed use is also less nutrient efficient, resulting in higher levels of N imported and more feed substitution.

Herbage DM production on Irish farms – PastureBase Ireland data (2013–17)

There is huge variation in grass DM production on farms. This is one of the key findings emerging from the analyses of data captured in PastureBase Ireland (www.pasturebaseireland.ie;

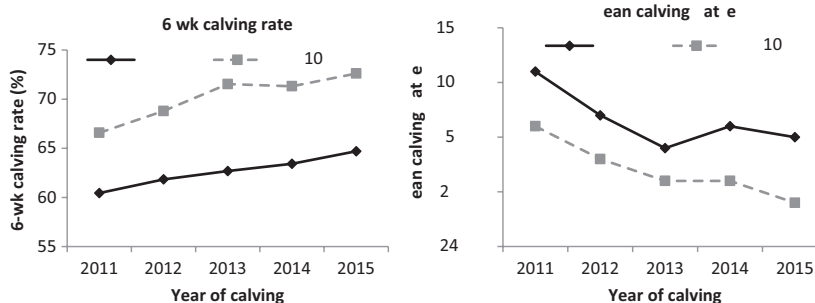


Figure 1. Trends for mean calving date and 6-wk calving rate for cows in the top 10% (broken grey line) and national average (solid black line) Economic Breeding Index (EBI).

Table 4: National farm survey technical performance indicators on Irish sheep farms 2011–2016

	2011	2012	2013	2014	2015	2016
Stocking rate (ewes/ha)	7.2	7.2	7.5	7.6	7.4	7.7
Weaning rate (lambs/ha)	1.3	1.2	1.3	1.3	1.3	1.4
Lamb carcass (kg/ha)	187	175	189	202	193	217

Source: Teagasc (2016b).

Hanrahan *et al.*, 2017). There are many reasons for this, including differences in stocking rate, soil fertility and grazing management practices. If soil fertility and grazing management can be improved, many farms are very capable of increasing their herbage DM production. High herbage DM production can be achieved on dairy and drystock farms,

irrespective of location, through good grazing management, soil fertility management, good grazing infrastructure, and use of perennial ryegrass + white clover swards.

Figures 2 and 3 show annual DM production data from dairy and drystock farms across Ireland in 2016. These farmers have recorded >30 weekly farm walks (weekly assessment and recording of herbage mass present on all paddocks on the farm). In 2013, these farms produced an average of 12.2 t DM/ha. This increased to 13.5 t DM/ha in 2014, highlighting the year effect on grass growth. The variation between farms is very high; the difference between the lowest and highest producing farms was 9.4 t DM/ha. An important aspect of the herbage DM production data is that the highest producing farms are growing >16.0 t DM/ha, with little variation between paddocks. The lower producing farms have much greater variation between individual paddocks. In 2015, there was an increase of 0.6 t DM/ha compared to the previous year; on average dairy farms grew 14.1 t DM/ha. Much of the extra herbage produced in 2015 was grown by April, and the mid-year grass growth profile was consistent

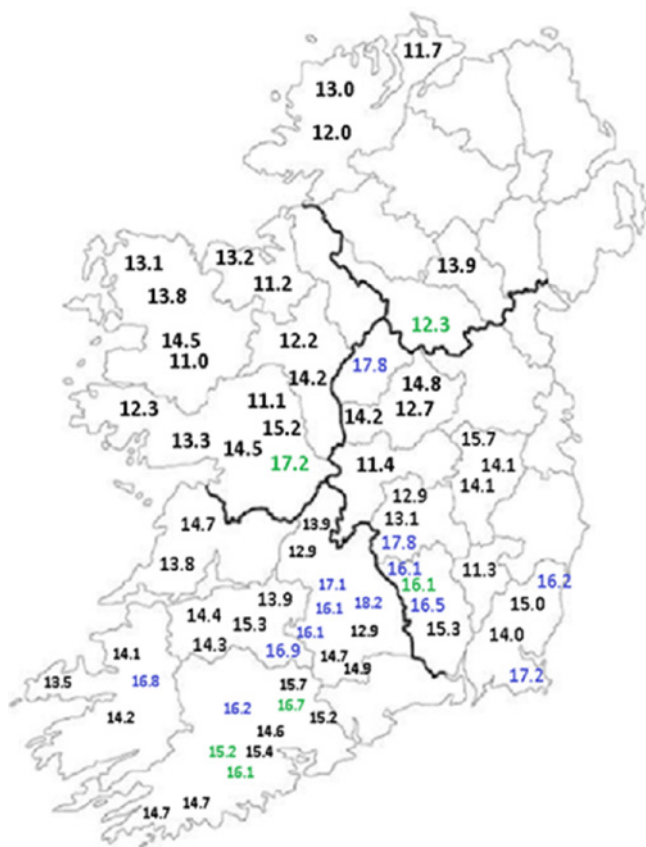


Figure 2. Grass DM production (t DM/ha) from PastureBase Ireland dairy farms across the country in 2016.

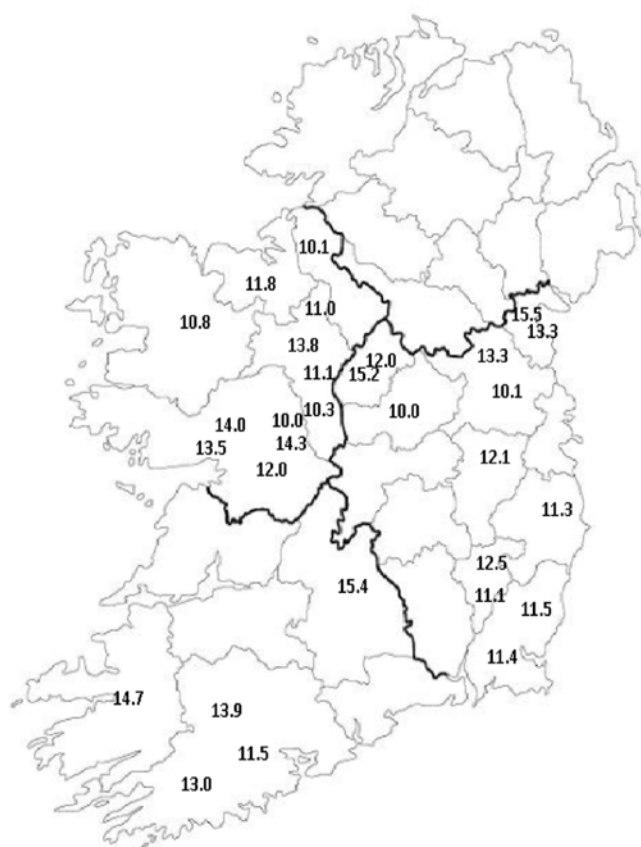


Figure 3. Grass DM production (t DM/ha) from PastureBase Ireland drystock farms across the country in 2016.

with 2014. After a period of slow grass growth in spring 2016, growth recovered well in May, however, there was 0.3 t DM/ha reduction in DM production with the average dairy farm producing 13.8 t DM/ha.

Increased herbage DM production is necessary to meet the increased feed demand on farms as stocking rate increases. Increases in stocking rate have occurred predominantly on dairy farms, and to a lesser extent on intensive beef and sheep farms. The optimum stocking rate for an individual farm is that which gives sustainable profitability and is dependent on the individual farm's grass growth capability. Another way of describing stocking rate is livestock carrying capacity. The livestock carrying capacity is the amount of forage available for grazing animals based on total annual production. The livestock carrying capacity is the maximum stocking rate possible, depending on livestock type/weight and nutrient requirements. Many Irish farms are only achieving 50–60% of their grass growth potential. Research studies looking at the effect of increasing stocking rate on herbage DM production and utilization within both dairy (McCarthy *et al.*, 2012) and sheep systems (Earle *et al.*, 2017) show great potential to increase farm productivity and demonstrate that dairy and drystock systems are equally capable of growing and utilising increased levels of grass at farm level. A recent survey of high performing grassland farmers found that they all agreed that they were completing more farm walks (industry target – 30 grassland measurements per year), grazing their cows to lower post grazing heights (industry target – 4.0 cm) and reseeding more than they were 5 yr ago. This shows that continuous improvement in grazing management practice can result in increased herbage DM production.

Increase in stocking rate

Irish dairy farmers are growing 9.1 t DM/ha (McEvoy *et al.*, 2011) and have a 220-d grazing season. Drystock farmers

that are measuring grass routinely are growing 12.2 t DM/ha (O'Donovan *et al.*, 2016). The bottom 20% farms recording grass measurements into PastureBase Ireland are growing 11.0 t DM/ha, the average PastureBase Ireland farm is growing 13.8 t DM/ha, while the top 20% of PastureBase Ireland farms are growing 16.7 t DM/ha (Figure 4). The variation in seasonal herbage DM production on PastureBase Ireland farms is as follows: 816–1,199 kg DM/ha in spring (January to 10 April), 4,462–4,932 kg DM/ha in mid-season (11 April to 31 July), and 5,937–6,442 kg DM/ha in autumn (August to December). The farms producing the greatest quantity of herbage are achieving an extra grazing per year compared to the farms producing the least (7.7 and 6.8 grazings/paddock per year, respectively). There is a strong relationship between the number of grazings per year and herbage DM production. The extra grazing results in more grass in the diet of grazing livestock, reducing the requirement of supplement, and providing an extra 20 grazing days per year.

Grass-clover systems

Forage legumes, and white clover (*Trifolium repens* L.) in particular, have the potential to positively influence the sustainability of pasture-based ruminant production systems. There is increased interest in the use of clover in Ireland because it offers opportunities for sustainable pasture-based production systems. A recent meta-analysis (Dineen *et al.*, 2017) was undertaken to quantify the milk production response associated with the introduction of clover into perennial ryegrass swards. The analysis found that at a mean sward clover content of 31.6%, mean daily milk and MS yield per cow were significantly increased by 1.4 and 0.12 kg, respectively, compared to grass only but there was no significant effect on milk yield and MS yield per ha. Within this analysis stocking rate and N fertilizer application were reduced by

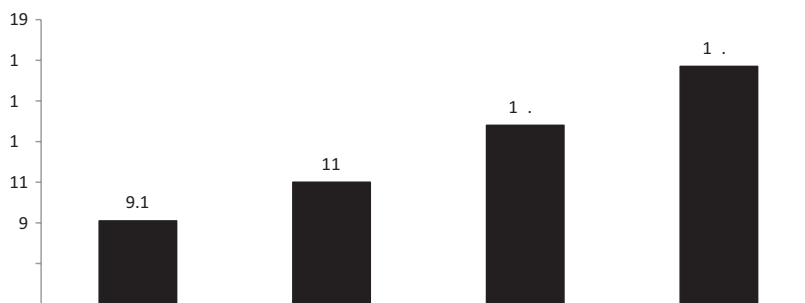


Figure 4. Average herbage DM production (t DM/ha) of national average dairy farms and farms in the bottom 20%, average and top 20% recording into PastureBase Ireland.

0.25 cows/ha and 81 kg/ha, respectively, on grass–clover (3.32 cows/ha) swards compared with grass only (3.57 cows/ha) swards.

The most recent grass–clover research undertaken in Ireland at Teagasc Moorepark and Clonakilty has shown clear advantages of combining perennial ryegrass and clover compared to perennial ryegrass only. Dineen (2017) over a 2 yr period, reported that, at the same stocking rate (2.75 cows/ha) and N fertiliser application rate (250 kg N/ha), cows grazing grass–clover produced an additional 647 kg of milk and 55 kg MS per cow, compared to cows grazing grass only, which equated to an additional 1,781 kg milk and 151 kg MS/ha. Total herbage DM production was 2.5 t DM/ha greater on grass–clover swards compared to grass-only swards. That experiment is being undertaken for a further 3 yr to determine if those differences persist over time. Another farm systems experiment was undertaken at Teagasc, Moorepark, Ireland from 2013 to 2016. The experiment compared herbage and milk production from a grass-only sward receiving 250 kg N/ha per year and grass–clover swards receiving 250 or 150 kg N/ha per year (Hennessy *et al.*, 2017). Each treatment was stocked at 2.74 cows/ha. Annual herbage DM production was similar on all treatments (14.6 t DM/ha) across the 4 yr of the experiment. Average annual sward clover content was greater on grass–clover receiving 150 kg N/ha (27%) compared with grass–clover receiving 250 kg N/ha (23%). MS yield was greater on the two grass–clover treatments (495 kg MS/cow per year, respectively) compared with the grass-only treatment (460 kg MS/cow per year).

Improved delivery from grass breeding and evaluation systems

Perennial ryegrass forms the basis of grassland production in Ireland and is the most important forage grass. Over 95% (3,624 t) of all seed sold in Ireland is perennial ryegrass, and 4% (140 t) is white clover. There has been large plant breeding industry investment in producing new varieties and independent testing systems designed to identify and list those with the most improved performances over the past 40 yr. In Ireland, McDonagh *et al.* (2016) compared the DM yield and sward density of new grass varieties submitted for evaluation from 1973 to 2013, and grass digestibility of grass varieties from 1980 to 2013, under conservation and simulated grazing managements. DM yields showed an overall significant ($P < 0.001$) average annual increase of 0.52% under conservation and 0.35% under simulated grazing, with similar levels of gain within maturity groups and ploidies. These rates were not constant over time, and periods of no gain occurred in various variety groupings. Sward density did not change significantly in the study period. Herbage digestibility showed

no improvement over the timeframe but had the largest differences between concurrent varieties, indicating that improvements were possible in the future. The study indicated that plant breeding gains were primarily DM yield focused with sward density remaining stagnant over the 40 yr, while the lack of grass digestibility improvement appeared to only require more time to overcome.

McDonagh *et al.* (2016) have shown that perennial ryegrass breeders have achieved low increases in DM yield production over time. Given that the recognition of digestibility improvement was only relatively recently introduced to the testing system, further advances will need to be realised. The introduction of the Pasture Profit Index (PPI, McEvoy *et al.*, 2011; O'Donovan *et al.*, 2017) into the Irish Recommended List for Grass and Clover, combined with the change to evaluation under intensive simulated grazing protocols and more on farm grass and clover variety evaluation using PastureBase Ireland will bridge the gap between farmers, evaluation and breeding. Although there is a general consensus amongst breeders internationally that individual varieties can perform well in a range of environments, in fact the evidence from the PPI and the Irish Recommended List for Grass and Clover clearly shows that the best performing breeding programs for Ireland are those based in Ireland and the United Kingdom. It is likely that this trend will only become more obvious as a result of the development of the PPI given Ireland's huge dependence on grazed pasture. The grass varieties of choice in Ireland into the future grass will be those with high levels of graze out – ultimately these varieties will require better sward canopy characteristics. New focus on the development of a clover profit index for white clover breeding and evaluation will put more focus on the development of clovers for grazing systems, it may drive a change in clover breeding leading to high seasonal contributions from clover, which is required. There is also a requirement for grazing red clovers to be bred, little success as yet as been recorded on grazing red clovers although some New Zealand programmes are well into this development. With clover, whether it is white or red clover, the long-term persistence in the sward continues to be a huge challenge. Future grass and clover breeding and evaluation in Ireland will be designed to satisfy the end demands of the grassland farmer.

Future direction and focus

The success of Irish grass-based production systems is very dependent on five main challenges:

- i. Continued adoption at farm level of improved grassland management practises and grassland technologies, much of the new focus will be on better nutrient management and ensuring a better agronomic return for chemical and organic fertiliser inputs

- ii. Focussed research on grazing management to optimise herbage DM production, quality and utilisation, as well as development of grassland management tools to facilitate improved grassland management practises
- iii. Requirement to develop and maintain high clover proportions in grazing and conservation swards
- iv. Ensure farm sustainability is improved and optimised with grassland as the main feed
- v. Ensure that livestock farmers maintain efficient low cost-high grass-based systems
- vi. Ireland is well placed to make further increases in grassland production; Irish farmers are keen adopters of grassland technology.

Ireland has successfully maintained the ethos of developing the family farm through sustainable grassland production; the Irish future success depends on improving this standard further.

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