UCD Lyons Systems Herd Annual Report for 2021

Project Title: Development of a Profitable High-Output Grass-Based Spring Milk Production System

Rationale: It is widely recognised that grass-based systems will predominate in Ireland. However, grazing systems that have been developed to utilise large quantities of grazed grass have in the main been based on low output per cow. In this scenario, high levels of profitability are possible through avid cost control and comparatively high stocking rates for grazing systems. There are now reasons to consider the development of grazing systems that are based on high output per cow. These reasons include (i) concerns about increasing dairy cow numbers and environmental emissions, (ii) facilitating farm expansion for land limited and fragmented farms, (iii) lack of available skilled labour on farms and (iv) lack of infrastructure on farms to deal with expanding animal numbers.

Project objectives:

- To develop a profitable high-input high-output grass-based spring milk production system
- To incorporate the most recent advances in grassland management for dairy farms into a high-output system
- Use a type of dairy cow that has good genetic indices for both milk production and fertility
- Employ the best practices from nutrition research and dairy cow husbandry
- Incorporate nutritional studies into a high-input high-output system
- To incorporate management technologies and system attributes that enhance the sustainability and economic viability of dairy production

Description of the project:

The targets for the system are presented in Table 1. The average genetic merit of the herd in January 2021 is presented in Table 2. In the January 2021 evaluation, the overall herd EBI was within the top 1% nationally, with milk sub-index (SI) in the top 1% and herd fertility SI in the top 5%. Cows calved from the 30th January to 11th April 2021. The feed budget is calculated on a days in milk (DIM) basis (Table 3). The whole farm stocking rate for the system (2.33 LU/ha) would be in compliance with the 2021 DAFM proposal to introduce banding of dairy herds based on milk output as part of compliance with the EU Nitrates Directive Derogation.

Table 1: Targets for the system

Parameter	Target
Stocking rate on milking platform	3.27 LU/ha
Stocking rate whole farm	2.33 LU/ha
Milk yield kg/cow	7,500-8,000
Milk solids kg/cow	625
6-Week in calf rate	75%
Concentrate (kg/cow/year)	1,500
% diet as grazed grass	>51
% diet as grazed grass and grass silage*	>75

***c.93-94% on an as-fed basis**

Table 2: Genetic merit of the herd (ICBF January 2021 evaluations)

EBI	Milk	Fertility	Calving	Beef	Maint.	Health	Mgt
204 (Top 1%)	69 (Top 1%)	81 (Top 5%)	43 (Top 1%)	-10 (Top 1%)	11 (Top 30%)	6 (Top 5%)	3 (Top 20%)
Milk kg	**Fat kg**	**Prot. Kg**	**Fat %**	**Prot. %**	**Calv int.**	**Surv %**	
152 (Top 20%)	13 (Top 5%)	10 (Top 5%)	0.11 (Top 20%)	0.08 (Top 10%)	-4.1 (Top 1%)	2.4 (Top 1%)	

Table 3: Feed budget for 2021 (Target allowances and actual feed budget for the year)

Days in milk	0-20	21-60	61-90	91-120	121-180	181-240	241-270	271-305	306 -343	344 - 365	Total annual (Est)	Total annual (actual)
Silage kg DM/cow/day	5	0	0	0	0	0	5	15	10.7	8.5	1.3t DM	1.8t DM
Grass kg DM/cow/day	10	15	15	15	15	14	7.5	0	0	0	3.5t DM	3.1t DM
Concentrate kg/cow/day	8	8	7.5	6	3.5	3	3	3	0	0	1.5t As fed	1.5t As fed

2016-2021 Production Performance

Table 4: Herd milk performance in 2016 -2021

Parameter	2016	2017	2018	2019	2020	2021
Cow numbers	58	60	59	58	57	57
Milking Platform ha	17.58	17.65	17.65	17.52	17.43	17.43
Silage ha	9	7	7	7	7	7
Whole farm ha	26	24.65	24.65	24.52	24.43	24.43
SR on MP	3.3	3.4	3.34	3.31	3.27	3.27

SR whole farm	2.18	2.4	2.4	2.34	2.33	2.33
% heifers in herd	22.4	23.3	28	21	23	23
Average lactation days	301	305	305	304	305	298
Average fat %	4.60	4.49	4.45	4.33	4.48	4.49
Average protein %	3.56	3.66	3.62	3.60	3.59	3.64
Average lactose %	4.51	4.48	4.54	4.53	4.56	4.46
Average SCC	111,000	91,500	154,000	56,000	58,000	50,000
Yield/cow (305d)	7,441	7,548	6,680	7,541	7,771	7,744
Milk solids/cow (305d)	592	602	558	597	621	630
Yield/cow (actual)	7,407	7,466	6,790	7,381	7,503	7,733
Milk solids/cow (actual)	588	595	544	586	606	629
Milk solids/ha MP	1,953	2,023	1,850	1,940	1,980	2,057
Milk solids/ha whole farm	1,291	1,428	1,306	1,371	1,413	1,468

Figure 1. Milk kg production comparing 2021 and 2016-2020 average

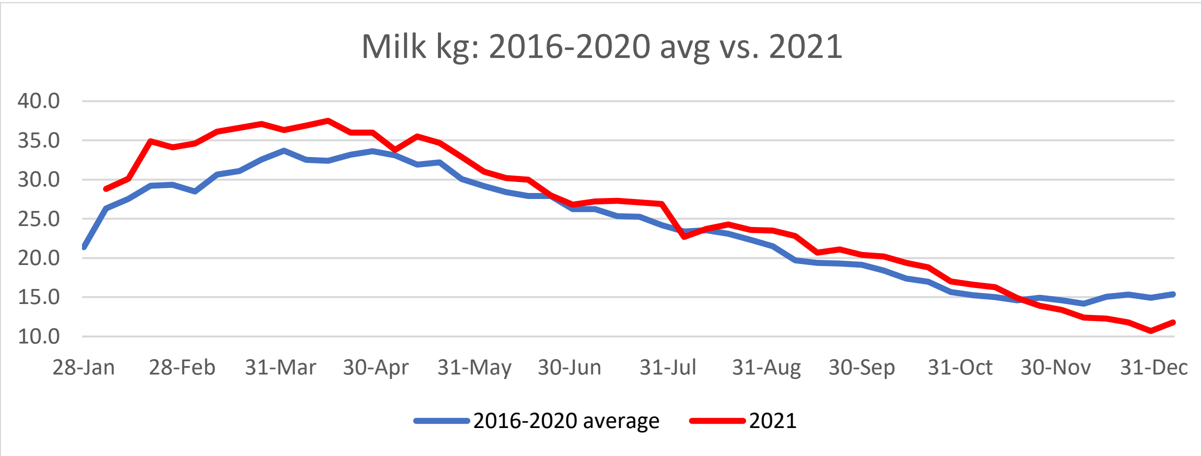


Figure 2. Milk solids (kg) production comparing 2021 and 2016-2020 average

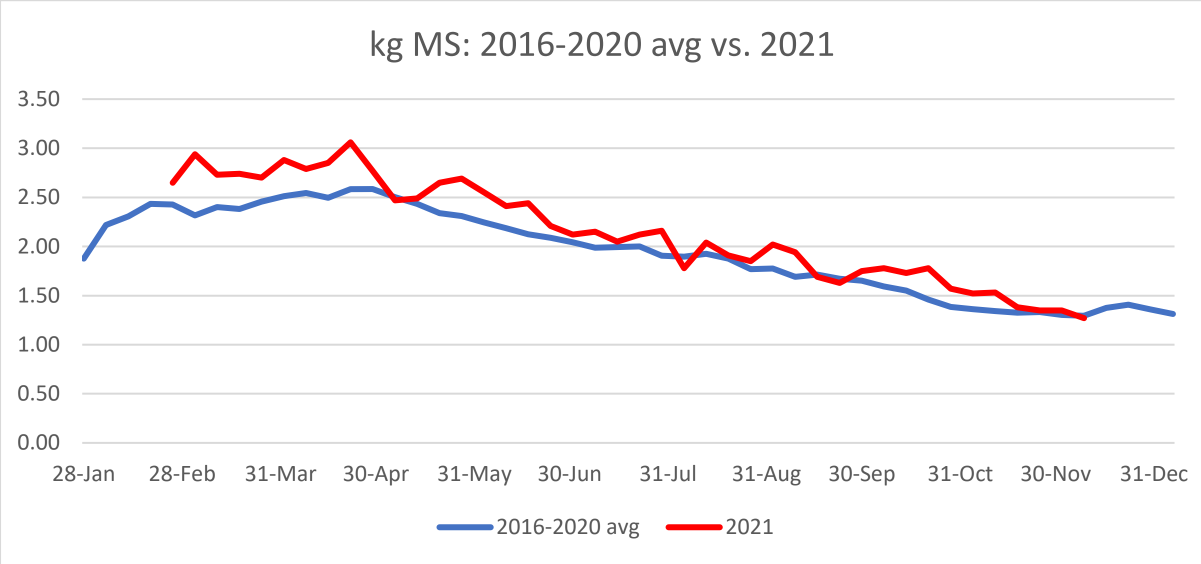
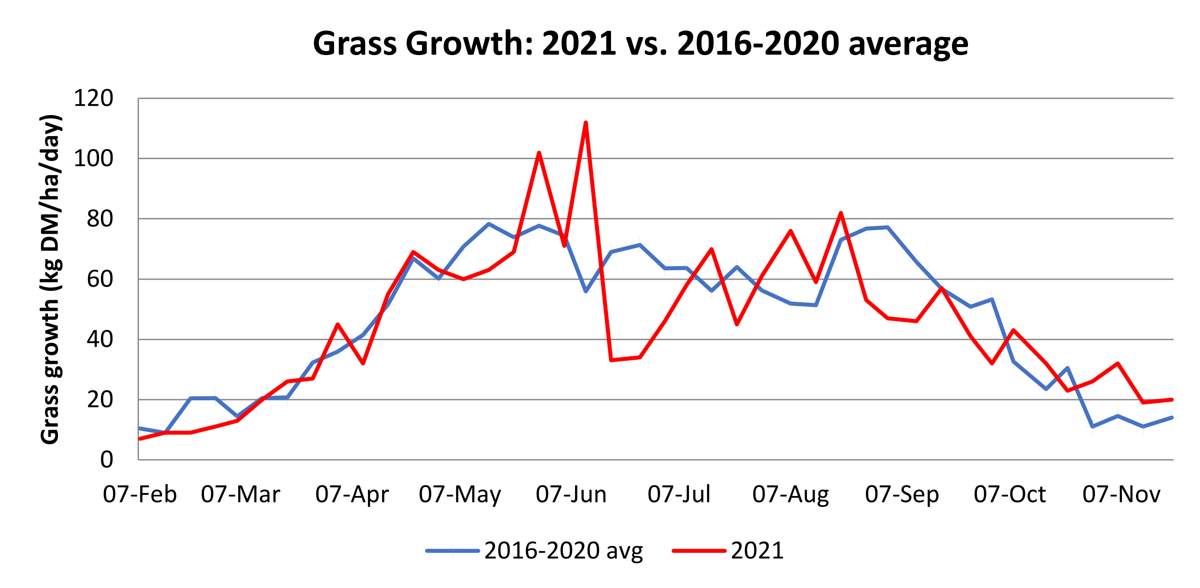


Table 5: 2021 Grass production data (Milking Platform)

Grass Production Parameter	
Total grass grown (kg/ha)	13,807
Silage (bales) on MP (kg/ha)	1,421
Herbage utilized (kg/ha)	11,598
Grazed grass utilized (kg/ha)	10,177
Grazed grass utilized (kg/cow)	3,112
Total number of grazings	9.7
Opening cover on 11th Jan 2021 (kg DM/ha)	794
Closing cover on 1st December 2021 (kg DM/ha)	785
Stocking rate on MP	3.27
Nitrogen (kg N/ha)	210
Phosphorus (kg P/ha)	25.3
Potassium (kg K/ha)	95.3
Turnout by day	9th February
Turnout full time	16th February
Housed by night	20th October
Full time housing	18th November
Total days at grass	276
Milk from forage (kg)	4,829
Average concentrates consumed (kg/cow)	1,452
Average silage consumed (kg/cow)	1,746

Figure 3. Grass growth comparison between 2021 and 2016-2020 average



Breeding 2021

The breeding season began on the 1st May and finished on 9th July, lasting for 10 weeks. This year, 55/57 cows were bred (Table 6). Two cows were being omitted from breeding due to poor udder confirmation and locomotion and consistent SCC issues.

The 21-day submission rate was 94.5% (52/55 cows in the breeding herd). The 6-week in calf rate was 87% (48/55 cows). A 30-day scan found that 48/55 (87%) of the breeding herd were confirmed pregnant in the first six weeks of breeding based on a 30-day scan. Of these 39 held to the 1st serve (72%). There were 14 cows that received a 2nd serve, one of which cows repeated for a 3rd time. A total of 52/55 eligible cows (95%) were scanned as pregnant on 8th August. A final scan on 14th October determined that 2/55 submitted cows were empty. Therefore, including two pre-breeding culls, the 2021 breeding season empty rate is 7% (4/57 cows).

Breeding is all by A.I and is done twice daily. Bulls selected are FR5860 (Saintbrigid Frank Joseph), FR6139 ((Ig)Lisduff Perception), FR5857 (Olcastletown Tiernan), FR6061 (Munta Mystic), FR5668 (Peak Chilton-Et), FR4573 (VH Praser), FR5971 (Viaductview Fiveo), FR2400 (S-S-I Headway Alltime-Et) and FR5239 (Hanrahan Olympus).

The weighted EBI averages of these bulls used were as follows:

EBI €	Milk SI	Fert SI	Calv €	Beef €	Maint €	Manag €	Health €	Milk kg	Fat kg	Prot kg	F+P kg	F%	P%
281	116	108	44	-9	4.1	2	17	360	22	18	40	0.13	0.09

These bulls were selected to ensure an equal spilt in the EBI of the herd between Milk SI and fertility SI. Bulls are chosen with high milk fat and protein milk PTA to ensure the milk fat and protein % stay positive in addition to selecting for a good health sub-index values. Nine bulls were selected to increase bull team reliability. Heat detection is being done using automated devices and scratch cards which are read in the collecting yard. From the 8th breeding week onwards, selected beef bulls were used for the remainder of the breeding season. The beef bulls that will be used are AU4460 (Dauphin), AU4563 (Johnstown Loyd), LM2014 (Ewdenvale Ivor) and SA2189 (Ulsan).

Breeding Results 2021

Table 6: Percentage of cows submitted by breeding season week in 2021

	% of cows submitted (numbers)
Week 1	29% (16/55 cows)
Week 2	63% (35/55)
Week 3	95% (52/55)
Week 4	95% (52/55)
Week 5	96% (53/55)
Week 6	98% (54/55)
Week 7	100% (55/55)

Table 7: Fertility performance of the herd 2016-2021

	2016	**2017**	**2018**	**2019**	**2020**	**2021**
Number of cows bred	58 (of 58)	59 (of 60)	55 (of 60)	58 (56 submitted)	57 (54 submitted)	57 (55 submitted)
Submission rate 21 d%	91	90	96	95	91	95
First service conception rate %	43	49	69	60	74	72
6-week pregnancy rate %	59	54	83	79	87	87
Empty rate of total cows %*	9 (5/58)	15 (9/59)	13 (7/55)	12 (7/58)	9 (5/54)	7 (4/57)

Pregnancy scans were done weekly, at approximately 30- and 60-days post A.I. Final 30-day scan was carried out in August, with two cows overall scanned empty.

Financial Simulation

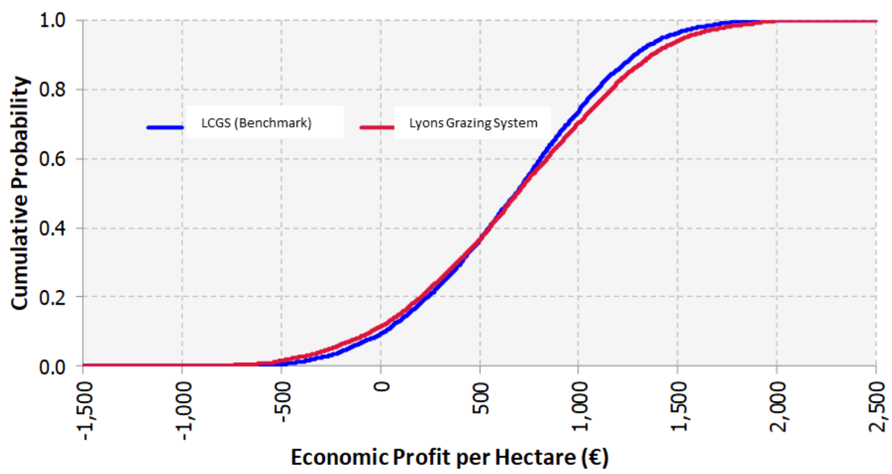
In order to evaluate the profitability of the Lyons dairy system, financial simulations were undertaken. To do this, the Lyons Grazing System was compared to a benchmark low concentrate grazing system (LCGS), using characteristics as described in Table 8. This was a full assessment of production with labour priced at €15/hour, imputed rent (all land) at €420/ha and interest of capital at 5%. The milk output value was based on a milk base price of 30c/litre and concentrates were priced at €340/t DM.

Table 8: The characteristics of the benchmark LCGS and the Lyons grazing system

	Low concentrate grazing system (LCGS)	UCD Lyons grazing system
Stocking rate (LU/ha)	2.75	2.4
Milk yield (kg/cow)	5,550	7,450
Milk solids (kg/cow)	450	590
Concentrate (kgDM/cow/yr)	350	1,300
% diet grazed grass	74	53
% diet grazed grass and silage	90	78

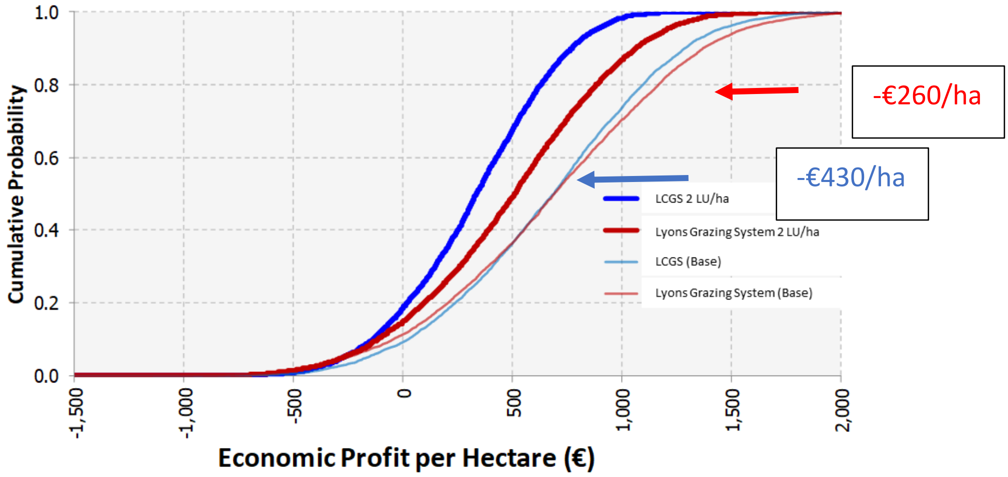
Using a cumulative profit distribution, analysis was carried out to compare the economic performance of the Lyons Grazing System to the benchmark Low Concentrate Grazing System (LCGS). The horizontal axis charts the profit/ha performance (- €1,500 to €2,500 in increments of €500) and the vertical axis charts the cumulative probability (Figure 4). This analysis enables the assessment of each system's probability of being below each profitability/ha performance increment. For example, at the breakeven point of €0, the systems had similar probabilities of being below that level of about 10%. At the midpoint probability rate of 50%, both systems had similar levels of profit/ha. However, at the upper end of the distribution, the Lyons Grazing System provides an upside economic potential when milk prices are high. This is due to the higher levels of milk production in the Lyons Grazing System than as simulated in the LCGS. Despite this, when milk prices are lower, the MCGS can lead to lower levels of profit. Overall, the level of risk is similar between the two systems.

Figure 4. Comparison of the cumulative profit distributions of the LCGS and Lyons Grazing System for profit/ha



A Monte Carlo analysis was performed to compare the level of profit/ha in a non-derogation scenario where stocking rates are reduced in both the Lyons Grazing System and LCGS system (Figure 5). Firstly, each system's current base figures are presented in the thin distribution lines. When the proposed SR restriction of 2 LU/ha is included in the simulation, both systems experience a reduction in profit through removal of derogation. The average profitability loss is €260/ha for the Lyons Grazing System and €430/ha for the LCGS. This analysis illustrates that the Lyons Grazing System can perform to a superior degree if SR is curtailed to 2.0LU/ha. This is due to the higher levels of output/cow which is a characteristic of the Lyons Grazing System.

Figure 5. Comparison of the cumulative profit distributions of the LCGS and MCGS with and without nitrates derogation scenarios.



Nitrogen Balance and Nitrogen Use Efficiency (NUE)

Pasture-based dairy systems rely on the maximisation of grazed grass throughout the grazing season as the main source of forage for dairy cows. However, Nitrogen (N) inputs (eg: fertiliser and concentrates) are key drivers of these production systems and they exceed farm N outputs (eg: milk and livestock) that are exported off the farm. This is particularly problematic as when it is leached into waterways, N can deteriorate water quality and lead to anthropogenic acidification of soils. The assessment of farm-gate N balance and its efficiency enables an assessment of a farm's sustainability performance.

Detailed farm records were recorded from production details from the UCD Systems herd from 2016-2021 as part of this study to determine the farm gate nitrogen (N) balances and nitrogen use efficiency (NUE). Both are calculated as described by (Buckley et al., 2015):

$$\text{Farm gate N balance (kg N/ha)} = \frac{\text{Total N inputs (kg)} - \text{Total N outputs (kg)}}{\text{Utilisable Agricultural Area (ha)}}$$

$$\text{NUE (\%)} = \frac{\text{Total N outputs (kg)}}{\text{Total N inputs (kg)}} \times 100\%$$

The N balance and NUE % of each year is detailed in Table 9. In this project, heifer calves are contract reared so they leave the farmgate as calves and re-enter at the start of their first lactation period. Nitrogen balance was highest and NUE % was lowest in 2018. Due to the lengthy drought conditions that were experienced in 2018, inputs (especially fertiliser, concentrates and forage feeds) were higher than any other years. The other years indicate that the N balance and NUE % are improving, with fertiliser and concentrates decreasing and milk yield steadily increasing. For comparison, the latest Teagasc National Farm Survey reported that the average NUE of dairy farms in 2020 was 25.6%. In 2021, our N balance was 176.8 kg N/ha and NUE was 39.6% which is the highest of all the years since the project began. This was driven by lower protein concentrates being offered and a higher milk output by the herd in 2021.

Table 9: Nitrogen Use Efficiency (NUE) of the herd 2016-2021

	2016	**2017**	**2018**	**2019**	**2020**	**2021**
N inputs (kg N/ha)						
Chemical fertilizers	213	242	263	224	214	214
Concentrate Feeds	85.1	92.5	82.3	96.0	75.7	67.4
Forage feeds (incl. straw bedding)	2.7	2.9	13.9	3.0	3.0	2.8
Livestock	5.72	7.00	9.32	6.1	8.7	5.7
Calf feed	2.1	2.4	3.1	2.5	2.6	2.6
Total	308.2	346.5	372.0	331.6	303.9	292.5
N outputs (kg N/ha)						
Milk	90.0	104.1	92.1	98.4	98.4	101.1
Livestock	12.9	16.1	13.3	19.5	16.2	14.6
Total	103.0	120.2	105.4	117.9	114.6	109.4
N balance (N/ha)	205.2	226.3	266.6	213.7	189.4	176.8
Farm Gate NUE (%)	**33.4**	**34.7**	**28.3**	**35.6**	**37.7**	**39.6**

Recent research

2019 Trial

It is well established that in high crude protein diets, the amount of protein degraded in the rumen can be in over supply. If the rumen degradable protein exceeds microbial needs, large amounts of NH_3 are produced, absorbed into the blood, converted to urea in the liver, excreted in the urine and thus lost to the environment. Therefore, our aim was to compare high and lower crude protein % in the concentrate to evaluate nitrogen use efficiency.

- Treatment 1= High CP concentrate (18%) throughout the main grazing season
- Treatment 2= Low CP concentrate (14%) for the main grazing season

Statistical analysis was carried out to determine the milk production differences between both CP% groups during the main grazing season (2nd April-7th October 2019). Both groups had similar milk yields, fat kg, protein kg, MS kg, fat %, protein % and somatic cell count (SCC). The 14% group had higher levels of N intake but the 18% group had a slightly higher NUE % (Table 10). These results indicate that the milk production of high EBI cows is not inhibited by reducing concentrate CP levels from 14%-18%. However, the cows offered the 14% crude protein concentrate had a higher overall intake and that resulted in lower N utilisation.

Table 10. Differences in milk production, nitrogen intakes and NUE between the 14% and 18% crude protein groups during the main grazing season in 2019.

Parameter (per day)	14% CP	18% CP	Significant Difference (P-value)
Milk yield (kg)	29.9 ±0.83	29.4 ±0.85	No (*P*=0.38)
Fat (kg)	1.21 ±0.04	1.12 ±0.04	No (*P*=0.68)
Protein (kg)	1.06 ±0.03	1.03 ±0.03	No (*P*=0.45)
MS (kg)	2.27 ±0.06	2.21 ±0.07	No (*P*=0.54)
Fat (%)	4.08 ±0.08	4.10 ±0.08	No (*P*=0.90)
Protein (%)	3.56 ±0.03	3.52 ±0.03	No (*P*=0.42)
SCC (× 10^3 cells/ ml)	68.4 ±12.1	84.5 ±12.5	No (*P*=0.77)
Pasture N intake (kg)	0.49 ±0.01	0.46 ±0.01	Yes (*P*<0.0001)
Total feed N intake (kg)	0.57 ±0.01	0.55 ±0.01	Yes (*P*<0.0001)
NUE (%) of individual cows	20.9 ±0.68	23.2 ±0.68	Yes (*P*=0.03)

2020 and 2021 Nutrition Trial

Based on our 2019 findings, there was a continued focus to assess the effect of different concentrate crude protein levels on pasture milk production and composition and nitrogen use efficiency in a high EBI, high-output grass-based spring calving herd.

In 2020 and 2021, cows were offered one of the following concentrates during the main grazing season:

- **Treatment 1**= 14% CP concentrate throughout lactation
- **Treatment 2**= 12% CP concentrate formulated with native ingredients
- **Treatment 3**= 12% CP concentrate formulated with non-native ingredients

Table 11. The average milk production performance of the three concentrate groups during the 2020 study

Parameter (per day)	14% CP	12% CP Non-native	12% CP Native	Significant Difference (P-value)
Milk yield (kg)	26.7 ±0.63	26.2 ±0.64	25.3 ±0.63	No (*P*=0.31)

Fat (%)	4.42 ±0.09	4.29 ±0.08	4.42 ±0.09	No (*P*=0.43)
Protein (%)	3.61 ±0.04	3.65 ±0.04	3.65 ±0.04	No (*P*=0.65)
F+P (kg)	2.09 ±0.04	2.03 ±0.04	2.03 ±0.04	No (*P*=0.58)
SCC (× 10^3 cells/ ml)	74.0 ±12.9	72.2 ±12.8	78.1 ±12.7	No (*P*=0.58)

Table 12. The average milk production performance of the three concentrate groups during the 2021 study

Parameter (per day)	**14% CP**	**12% CP Non-native**	**12% CP Native**	**Significant Difference (P-value)**
Milk yield (kg)	25.7 ±1.1	25.3 ±1.0	24.9 ±1.0	No (*P*=0.85)
Fat (%)	4.4 ±0.12	4.44 ±0.12	4.37 ±0.12	No (*P*=0.91)
Protein (%)	3.66 ±0.05	3.64 ±0.05	3.66 ±0.05	No (*P*=0.94)
F+P (kg)	2.11 ±0.07	2.06 ±0.07	2.01 ±0.17	No (*P*=0.59)
SCC (× 10^3 cells/ ml)	46.6 ±7.1	48.3 ±7.1	60.9 ±7.0	No (*P*=0.30)

2022

Our research to date has shown that high-output pasture-based dairy cows offered concentrates formulated with native ingredients during the main grazing season have similar levels of milk production. Preliminary data also shows improved environmental impacts compared to dairy cows offered concentrates with high levels of imported ingredients.

It is known that dairy cow NUE is lower at the beginning and end of the lactation period. Therefore, research in 2022 will investigate the milk production and environmental impacts of feeding lower CP concentrates of native formulation throughout the full lactation (Figure 6).

Figure 6. 2022 UCD Systems herd research trial layout

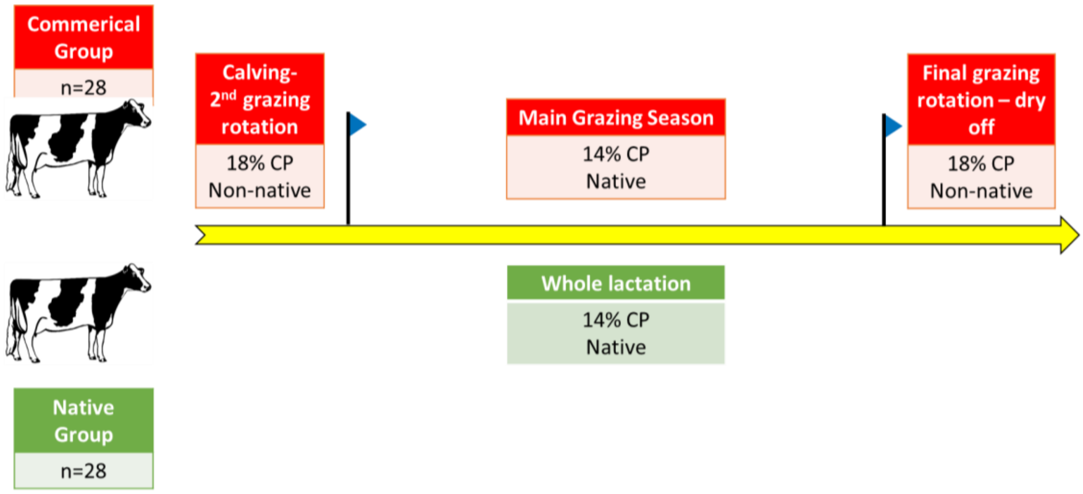


Table 13: Genetic merit of the herd (January 2022 evaluation)

EBI	Milk	Fertility	Calving	Beef	Maint.	Health	Mgt
213 (Top 1%)	74 (Top 1%)	85 (Top 5%)	42	-11	12	8	3
Milk kg	**Fat kg**	**Prot. Kg**	**Fat %**	**Prot. %**	**Calv int.**	**Surv %**	
173	13	11	0.11	0.08	-4.2	2.6	

Dissemination

- Weekly: Weekly notes are published on the Lyons Farm website (https://www.ucd.ie/lyonsfarm/research/dairyresearch/lyonssystemsresearchherdnotes/)
- Twitter: @UCD_SystemsHerd
- Industry and farmer groups are hosted on an ongoing basis
- A webinar was held on 14th January 2021. 350 people attended including viewers from Ireland, the UK and New Zealand.

Research Team

Prof Karina Pierce, Prof Finbar Mulligan, Dr Zoe McKay, Prof Michael Wallace, Prof Alan Fahey, Dr Paul Rice, Dr Nicholas Ryan and Niall Walsh.

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Dairy Research Ireland
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