Rialtas na hÉireann
Government of Ireland

Spending Review 2022

Review of the Beef Data Genomics Programme 2015-2021

ANTHONY CAWLEY AND CHARLIE BANKS

ECONOMICS AND PLANNING DIVISION,

DEPARTMENT OF AGRICULTURE, FOOD AND THE MARINE

December 2022

This paper has been prepared by IGEES staff in the Department of Agriculture, Food and the Marine. The views presented in this paper do not represent the official views of the Department or Minister for Agriculture, Food and the Marine.

IGEES
Irish Government Economic and Evaluation Service

Executive Summary

The Beef Data Genomics Programme (BDGP) has been operating in Ireland since 2015. The programme is co-funded by the European Commission and the Irish exchequer, with some €294m spent to date on participant payments and training costs. A centralised database is key to the programme, with data feeding into a star-based genomic breeding index that informs breeding-related decisions. The objectives of the BDGP are:

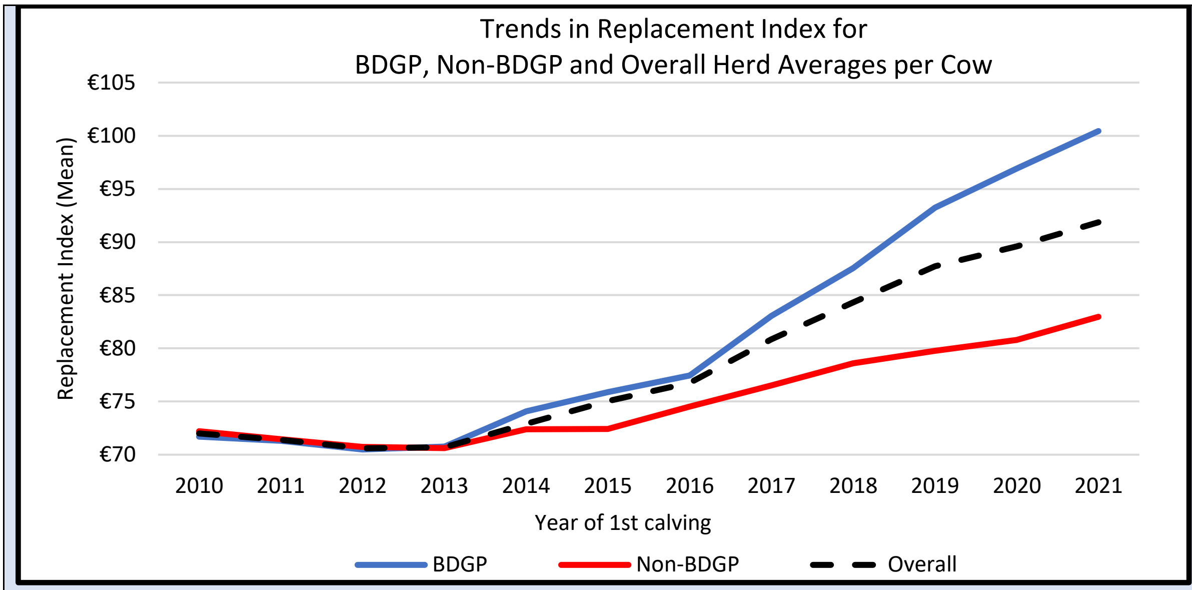
- To improve the genetic merits of the national beef herd through the collection of data and genotypes of selected animals which will allow for the application of genomic selection in the beef herd.
- To lower the intensity of GHG emissions by improving the quality and efficiency of the national beef herd.

A Spending Review paper on the BDGP published in 2019 showed preliminary evidence of positive gains towards the objectives and clear policy alignment with other interacting policies. However, it is now necessary to update this analysis to evaluate the continued progress, and to inform any potential new scheme designed for the upcoming new Common Agricultural Policy (CAP).

Payments amounting to over €285m have issued to 2021, with an average of approx. 22,600 farmers enrolled each year between 2016-2020 and circa 491,500 suckler cows enrolled in 2021 – equivalent to more than half the total number of suckler cows in the country. The average suckler herd in the 2021 scheme is estimated at approx. 22.8 suckler cows and participants received a mean payment of c. €1,950 per annum during 2015-21.

Descriptive data shows that BDGP participants tend to generally farm larger areas, hold higher numbers of stock, produce more output and earn higher incomes on average when compared with non-BDGP participants or the overall population of beef farmers. Accordingly, BDGP participants also tend to have a larger overall emissions profile in absolute terms, but the unit emissions efficiency is generally superior and has improved at a faster pace than other farms since the scheme was introduced. This reflects the relatively larger scale and viability of farms that participate in BDGP, but also reflects that those are the farms making the largest genetic gains, which in turn can yield the largest benefit for mitigation potential for the future of the beef sector.

The trends in genetic gain – as illustrated by the replacement index – have been steadily increasing for BDGP herds over the period of the scheme and have built on the initial gains reported in the previous review. Non-BDGP participants also continue to benefit from a positive spill-over effect, although at a slower rate than BDGP farms, due to the availability of superior genetics for breeding overall. The trends are illustrated in the figure below:



In terms of the Key Performance Indicators (KPIs), the calving intervals have shortened, the number of calves per cow per year has increased, the percentage of heifers calving before 26 months old has increased and the age of first calving has decreased. These are all in line with the objectives of the programme and reflect a continuation of progress as reported in the previous review. The review also highlights that use of the Carbon Navigator helped to build awareness of the environmental performance of production. A number of additional metrics are set out below illustrating the variation within the herd, highlighting the importance of monitoring data and the potential for further improvements.

KPI / Sustainability Metric	Source	Standard Deviation	Bottom 20%	21-40%	Average	61-80%	Top 20%	Difference Top vs. Bottom 20%
Avg. Replacement Index (€)	ICBF (BDGP)	-	42	63	80	96	122	80.0
Cow Liveweight (KG)	BEEP-S	56	689	670	664	656	652	- 37.2
Calf 200-Day Liveweight (KG)	BEEP-S	34.8	280	280	285	286	287	7.1
Weaning Efficiency	BEEP-S	5.5	40.8	42.0	43.0	43.9	44.3	3.5
Calving Interval (Days)	ICBF (BDGP)	28.7	399	394	390	385	388	- 11.4
Calves per Cow per Year	ICBF (BDGP)	0.12	0.85	0.88	0.89	0.91	0.91	0.06
Profit per Livestock Unit (€)	Teagasc	-	207	219	238	244	262	55.0
Carbon Footprint (KG CO2e/KG Beef)	Bord Bia	1.82	13.16	12.97	12.82	12.42	11.91	- 1.3

Analysis completed by the ICBF shows that, if current genetic merit trends continue, the sector could emit 67.8 KT (2%) less CO^2eq at 2030 compared to 2020 for a constant population level. Further benefits could also accrue including for output, gross emissions, and emissions intensity per cow. A sensitivity analysis showed that mitigation at 2030 and 2035 could be further increased if the rate of genetic gain accelerates beyond its current trajectory, whilst also highlighting the benefit of the scheme versus the counterfactual of no scheme in place.

Recommendations

- A new iteration of BDGP is needed to ensure continued improvements, with a strong emphasis on a data-driven scheme which incorporates areas such as the highest possible level of genotyping, increased use of 4- and 5-star animals, and further recording of data on farms.

- Merge the data collected under BDGP with performance related data such as collected under the BEEP-S scheme to ensure a holistic approach to improving sector sustainability. This will help improve whole-of-life performance, leading to greater efficiencies which can provide economic and environmental benefits.

- Leverage Knowledge Transfer activities to improve and increase the impact of the Carbon Navigator and other tools at farm level.

- Continued research on environmental traits within the €urostar Index, such as through direct selection for methane traits to identify potential methods to accelerate environmental performance improvements. Similarly, further analyses into areas such as younger finishing age, informed by the data, could help to accelerate gains.

- Continue to drive progress to achieve heightened level of ambition on genetic gain to meet the dual objectives of economic and environmental efficiency improvements, including for new entrants to meet scheme requirements.

Glossary of Terms

BEEP-S	Beef Environmental Efficiency Programme – Sucklers
BDGP	The Beef Data Genomics Programme: a scheme operated by DAFM to improve the genetic merits of the national beef herd through genomic selection, lowering GHG emissions intensity by improving the quality & efficiency of the herd.
BVD	Bovine Viral Diarrhoea
Calving	The birthing of a calf by a cow.
Calving Interval	Gap in time between calvings for an individual cow.
CAP	Common Agricultural Policy
CAP 2021	Climate Action Plan 2021
Carbon Navigator	Tool utilised by BDGP participants to gauge environmental farm performance.
CO	Cattle Other
CR	Cattle Rearing
CO^2e	Carbon Dioxide Equivalents: unit of measurement for Greenhouse Gas emissions as adopted in IPCC AR4.
DAFM	Department of Agriculture, Food and the Marine
DPER	Department of Public Expenditure and Reform
ETS	European Union Emissions Trading System.
€uro Star Replacement Index (RI)	A beef breeding index rated as 1-5 stars, with five-star cows being the most efficient based on maternal traits.
Genotype	The collection of genes in an individual cow which determine genetic merit. Genomics is the study of an animal's DNA.
GHG	Greenhouse Gas Emissions
Heifer	A cow that has borne one calf or less.
ICBF	Irish Cattle Breeding Federation
IPCC	International Panel on Climate Change
NFS	Teagasc National Farm Survey
NHD	National Herd Dataset
PI	Persistently Infected
Suckler Cow	A beef breed cow which produces/rears a calf for meat production and not to supply milk commercially.
Weaning Efficiency	The weight of a calf relative to its dam, calculated at an adjusted 200-day interval post-calving. This is an indicator of relative efficiency, with lighter dams producing heavier progeny scoring higher in terms of weaning efficiency.

Beef Data Genomics Programme

Introduction

The Beef Data Genomics Programme (BDGP) has been operating in Ireland since 2015 as one of the sustainability actions under the Rural Development Programme (RDP) to improve the genetic merit of the Irish beef herd and improve the environmental performance through quality and efficiency gains. The programme is co-funded by the European Commission under the European Agricultural Fund for Rural Development (EAFRD) and the Irish exchequer with some €294m spent to date.

A centralised database is key to the programme with data feeding into a genomics-based star-based breeding index that informs breeding related decisions through a €urostar[1] rating system, where with higher rated animals outperform and replace lower rated animals based on a range of indicators. This database is a key resource to ensure that the future beef herd in Ireland is superior in terms of its economic and environmental performance. The BDGP has provided invaluable data for this resource to help achieve the ambitions for the sector.

A Spending Review paper on the BDGP published in 2019 showed preliminary evidence of positive gains towards the objectives as well as clear policy alignment with other interacting policies. For example, the Beef Environmental Efficiency Programme for Sucklers (BEEP-S) collects performance related data to complement the genetic data captured under the BDGP. A Spending Review on BEEP-S in 2021 found that c. 85% of participants in BEEP-S also participated in BDGP. The combination of data from both Programmes will improve breeding related decision-making.

However, it is necessary to update the existing analysis of the BDGP to evaluate the continued progress to deliver the longer-term projections as set out in the Spending Review. Furthermore, given that the new Common Agricultural Policy (CAP) is schedule to commence in January 2023, it is important to ensure that any new scheme designed under the CAP is supported by a robust evidence base, utilising the most recent data available, to ensure that the schemes are positioned to deliver the necessary impact.

The purpose of this review is to provide that evidence base by:

- Examining the continued alignment of the BDGP with wider policy objectives; and
- Measuring the progress towards the intended impacts as set out in the Spending Review paper across a range of indicators.

The paper will follow the same programme logic model as used previously and the findings of this review will directly inform the design of a potential new scheme to be introduced under the new CAP.

[1] '€uro stars' are a calculated index based on the ancestry of the animal, their genotype and their performance. The '€uro' part refers to the additional gain in index value, and the 'star' refers to their classification with 5 star representing the top ranked animals

Context

The Irish beef sector is a structurally important indigenous industry, exporting 450,000 tonnes of output and representing 16% of total agri-food export value in 2021[2]. The sector has also been recognised in the Food Vision 2030 strategy as a principal driver of expanding Irish agri-food export destinations, with coverage in more than 70 countries. 57% of the 74,200 specialist beef farms nationally are located in the Border-Midlands-West (BMW) region. These farms represent 62% of all family farms in the BMW region[3], where overall agri-food represents approximately one in eight jobs compared to one in twelve nationally[4]. Beef output and processing have output multiplier coefficients of approx. 1.9-2.5, compared to 1.4 for the rest of the economy and 1.2 for foreign-owned firms, creating a significant contribution to the rural economy[5]. Grass-based beef systems, prevalent in Irish farming, also provide ecosystem services and can utilise land unsuitable for crops[6].

Beef farming is also a significant contributor to agricultural Greenhouse Gas (GHG) emissions and other environmental pressures. The development of the sector must be considered within this environmental context, as generating lower environmental pressures will ensure greater sector sustainability. EPA National Inventory Report figures for 2020 show Irish agriculture contributed 48% of national non-ETS (European Trading System) carbon-equivalent emissions (CO_2eq) and c. 37% of total Irish GHG emissions. This distinct emissions profile reflects the emissions intensity of ruminant livestock; the socio-economic significance of the agri-food sector in Ireland; and the relative lack of historical national industrial development.

The Climate Action Plan 2021 (CAP 2021) outlines targets and actions which will be implemented to meet a statutory target of a 51% reduction in national Greenhouse Gas (GHG) emissions by 2030 compared to 2018 and sets Ireland on a path to reach net-zero emissions by no later than 2050, as set out in the Climate Action and Low Carbon Development (Amendment) Act 2021. Under sectoral carbon budgets agreed by the Government in July 2022, the Agriculture sector has a target of a 25% reduction in GHG emissions, compared to 2018 output of approx. 23 MT CO2eq, to 17.25 MT CO2eq by 2030[7]. The plan for Agriculture in CAP 2021 includes a focus on stabilising methane emissions and achieving a significant

[2] DAFM (2022) Monthly Agri-Food Export Statistics.

[3] CSO (2021) Preliminary Results of the 2020 Census of Agriculture.

[4] Conefrey, T. (2018) *Irish Agriculture: Economic Impact and Current Challenges* in Central Bank of Ireland Economic Letters, Vol. 18, Issue 8, p.11.

[5] Grealls, E. and O'Donoghue, C. (2015) *The Economic Impact of Aquaculture Expansion: An Input-Output Approach* in Marine Policy, Vol. 81, pp.29-36; CSO (2018) *Input-Output Tables*

[6] Herron, J. et al (2021) *Life cycle assessment of pasture-based suckler steer weanling-to-beef production systems: Effect of breed and slaughter age* in Animal, Vol. 15, Issue 7, p.2:
"*Pastoral systems can also utilise land that is unsuitable for crop production, converting nonhuman edible forage into high-value human edible products. Grass-fed beef systems also provide ecosystem services such as the preservation and enhancement of biodiversity, conservation of cultural landscape, and contribute to the socio-economic activity in rural areas, in particular marginal areas*"

[7] Emissions expressed in terms of the IPCC AR5 accounting methodology, which increases the 2018 baseline emissions from the Agriculture sector from 22.03 MT CO2eq to approx. 23 MT CO2eq when compared with the IPCC AR4 emissions accounting methodology used in the National Inventory Report (NIR) to date. This is due to a higher methane and lower nitrous oxide carbon equivalence factors leading to a higher estimate in net terms.

reduction in fertiliser-related nitrous oxide emissions, among further measures such as through improved livestock management. Given the prominence of the beef sector within agriculture, it will play a significant role in contributing to the achievement of these targets.

From within this context the BDGP emerged, and continues to have relevance, with the broad objective to improve the genetic merits of the national beef herd by collecting genotypes and data which enables the selection of the most efficient animals for breeding. This contributes to improving the economic performance of those animals and also lowers the level of GHG emissions produced from the beef herd as less efficient animals are replaced. The dual benefits from these objectives represent a win-win for both farmers and the state as farmers will gain in profitability from more efficient animals and the associated benefit to the beef sector in terms of value and GHG emissions mitigated will benefit the state.

Programme Details

The objectives of the BDGP are:

- To improve the genetic merits of the national beef herd through the collection of data and genotypes of selected animals which will allow for the application of genomic selection in the beef herd.
- To lower the intensity of GHG emissions by improving the quality and efficiency of the national beef herd.

These objectives are interlinked as by improving the genetic trends will reduce the level of GHG emission per cow or per unit of output due to improved cow fertility, improved cow survival and reduced cow size (lower cow maintenance requirement such as feed). This ensures that the quality of the existing herd improves as opposed to the quantity of animals (which is positive for GHG emission targets as it reduces the number of animals required to produce a given level of output). The improved genetics will also ensure a cumulative and permanent improvement in the existing herd.

In order to achieve these objectives, participants must fulfil a range of criteria underpinning the BDGP to ensure compliance. Specifically, these actions include:

- Committing to the duration of the Programme.
- Recording specific animal data for calves, cows and bulls including sire details, calving ease, docility, vitality, size, quality and health traits, milk score, functionality and culling reasons.
- Genotyping priority animals in the herd by submitting a tissue sample for DNA analysis.
- Ensuring replacements are of 4 or 5 star quality by programme end (bulls must be genotyped 4 or 5 star; 20%/50% of females genotyped 4 or 5 star by 2018/2020).
    - *In 2021 and 2022, for continuing applicants, those participants using a stock bull must hold at least one genotyped four or five star bull on 30/06/2022; at least 80% of the Artificial Insemination used on holdings must be from four or*

five star bulls; and 50% of the reference number of heifers or eligible suckler cows must be four or five star on the holding at 31/10/2022.

- Completing a Carbon Navigator[8] which is an instrument to estimate emission levels and set targets for improvement of carbon efficient production.

In order to participate, farmers had to fulfil a number of eligibility criteria including their participation as part of the Basic Payment Scheme (BPS). A reference year of 2014 was set, except in exceptional circumstances for specific cases, and the number of calved cows that year was adopted as the number of reference animals, with the number of forage hectares declared in 2014 established as the eligible forage area. This was then recorded as the Maximum Payable Area, ensuring no incentive to increase the number of animals on the holdings to incur additional scheme payments. Instead, the incentive was to improve the genetic merit of the existing herd through an effective replacement strategy enforced by specified targets. In addition, a minimum of 80% of the reference area must be retained and 60% of the reference animals must be genotyped each year without repetition. The Programme involved a mandatory training programme provided by trained advisors which included information on replacement strategies and the Carbon Navigator[9].

Applicants were deemed ineligible where persistently infected (PI) Bovine Viral Diarrhoea (BVD) animals have not been removed from the herd, i.e. the death must be recorded on the Animal Identification Movement (AIM) within seven weeks of the initial test. Genomics should be seen as an integral part of an overall programme to improve cattle health to affect health and disease traits.[10] The BDGP facilitates this objective by helping to identify infectious cattle from the tissue samples collected, which can then be removed from the herd. The animal health actions undertaken under BEEP-S complement this objective.

Payments were calculated on the basis of the costs incurred and income forgone for actions such as collecting the data from the tissue samples, having the animals genotyped, and completing the Carbon Navigator. The BDGP was designed to incentivise farmers with smaller herd sizes (those with less than 10 cows) to participate, and these stocking rates were converted to a per hectare basis to align with the conditions of agri-environmental schemes under the RDP. Farmers would thus be paid on a set number of hectares calculated based on this conversion from the number of cows calved for the reference year of 2014 at a rate of 1.5[11], which could not be changed thereafter. This equates to 0.66 hectares for each suckler cow, or 6.66 hectares for the first 10 cows.

---

[8] Bord Bia (2015) "The Beef Carbon Navigator" available: https://www.teagasc.ie/media/website/about/our-organisation/Bord-Bia-Beef-Carbon-Navigator-LR4.pdf

[9] The Carbon Navigator is an online tool developed by Bord Bia and Teagasc that captures the actual carbon footprint of the farm and provides a menu of options to improve on this footprint.

[10] Berry, D. P., Meade, K. G., Mullen, M. P., Butler, S., Diskin, M. G., Morris, D. and C. J. Creevey (2011) "The integration of 'omic' disciplines and systems biology in cattle breeding' *Animal* **5**(4): 493-505.

[11] The conversion was based on a stocking density of 1.5 suckler cows per hectare to include the vast majority of suckler farmers profiled in the previous Beef Genomic Scheme data

The rates payable under the BDGP were as follows:

- €142.50 for the first 6.66 eligible hectares
- €120 for remaining eligible hectares

The degressive payment was introduced with a view to maximising the value for money based on previous experience, as participants gain economies of scale as tasks are repeated for higher numbers of animals/eligible hectares. To illustrate this, the average suckler herd in the BDGP scheme – using ICBF data for the overall population of herds and cows – is estimated at 22.77 cows in 2021, which equates to a gross payment of €1,971.22 for the average farm.[12]

The data collected through the scheme is a key asset that facilitates technological development which has continued to grow as more data has been recorded. The database is maintained by the Irish Cattle Breeding Federation (ICBF), and alongside Teagasc and the Department, these groups work together to ensure the scheme utilises this data to continue progress towards the objectives of the scheme.

Limitations

This paper analyses the existing evidence for trends in key indicators for relevant outcome variables, following a Programme Logic Model as with the previous review in 2019. This ensures a consistent methodology between the two papers. However, the analysis focuses on aggregated data as opposed to individual farm level data, so the findings must be interpreted as averages and the results at individual farm level will vary. Nonetheless, the results illustrate the overall trends compared to the baseline to highlight the changes induced by actions required under the scheme, and how this contributes to the data base which is a key tool for the further development of the sector.

Findings

Payments amounting to c. €295m have issued to 2021 which includes payments related to training. Approximately 22,000 suckler beef farmers were participating in the BDGP as of 2021 (which represents a drop off 760 herds compared to 2015) with c. 491,500 suckler cows (a decrease of c. 52,000 from the peak in 2017) which is over half the total number of suckler cows in the country (c. 896,000 as of 2021).

Some 5,000 applicants withdrew from the programme in 2015 prior to any payment issuing without carrying out any action under the scheme or incurring any costs. For the transitional schemes, as the replacement strategies for Stock Bulls and Heifers in years five and six had been costed on the basis of the six-year duration of the original scheme, participants could not be paid to carry out those required actions. However, in order to maintain the same level of payment under the transitional scheme, there was a maintenance payment for those that had successfully met the replacement requirements in 2019 and 2020 respectively. This saw some 1,968 participants unable to continue in the programme due to non-compliance with the original requirements. Table One identifies the trends in cows and herds from

---

[12] 22.77 cows equates to 15.18 ha once the 1.5 stocking density is converted. 6.66 ha paid at rate of €142.50 and the remaining 8.52 ha paid at €120 which equates to €949.05 + €1,022.17 = €1,971.22.

participating and non-participant herds, while Figure One illustrates the differences in mean herd by cohort.

	BDGP		Non-BDGP		Total	
Year	Herds	Cows	Herds	Cows	Herds	Cows
2015	22,346	518,359	48,133	498,731	70,479	1,017,090
2016	22,388	534,277	46,866	485,074	69,254	1,019,351
2017	22,366	543,379	45,463	465,987	67,829	1,009,366
2018	22,318	537,728	44,355	444,927	66,673	982,655
2019	22,242	527,383	42,818	417,265	65,060	944,648
2020	22,135	524,326	42,336	412,373	64,471	936,699
2021	21,586	491,451	41,368	404,382	62,954	895,833
2015-21 Change	- 760	- 26,908	- 6,765	- 94,349	- 7,525	- 121,257
% Change 15-21	- 3%	- 5%	- 14%	- 19%	- 11%	-12%
2020-21 Change	- 549	- 32,875	- 968	- 7,991	- 1,517	- 40,866
% Change 20-21	-2%	-6%	- 2%	- 2%	- 2%	- 4%

Table One: Number of Herds and Cows among BDGP and non-BDGP participants 2015-2021. Source: ICBF.

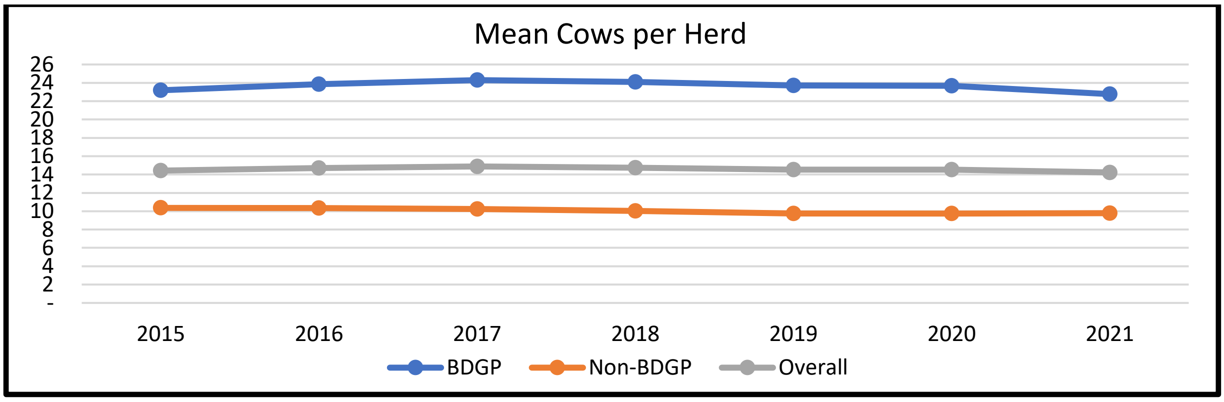


Figure One: Mean Cows per Herd. Source: Author's Calculations based on ICBF data (Total Cows / Total Herds).

The average herd size for BDGP participants over the lifetime of the scheme was 23.7 suckler cows although this figure has reduced by 6.3% from a peak of 24.3 in 2017 to 22.8 suckler cows as of 2021. This is in line with expectations as the actions implemented under BDGP aim to improve the efficiency of the system ie. produce the same or higher level of output from less animals. This compares to an average of c. 10 suckler cows for non-BDGP herds which has remained relatively stable over the period of the scheme within a range of 9.7 in 2020 to 10.4 in 2015, generally falling gradually over time. The overall number of cows per herd nationally stood at 14.2 in 2021, down marginally from 14.4 in 2015. These figures highlight that BDGP participants tend to have the larger herd sizes, which is important for schemes such as BDGP to incentivise the necessary actions now to improve the performance of the future beef herd.

Table Two highlights some of the key descriptive statistics to date. These figures indicate that approx. €293.9m has been spent during 2015-2021 on BDGP payments (€283.5m) and training costs (€10.4m). There was an average of over 22,600 participants within 2016-2020, with a lower number as the scheme became established in 2015/16 and as it was extended beyond its initial period in 2021. Overall, an average of 20,800 participants per year received an annual payment of approx. €1,948 or €132 per hectare overall, although this varied depending on the reference animals covered.

Key figures	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	***SUM TOTALS 2015-2021***	***AVERAGE PER YEAR 2015-2021***
BDGP Payments (€)*	28,989,048	50,801,060	44,218,425	44,776,287	41,447,273	41,495,019	31,752,988	*283,480,100*	*40,497,157*
BDGP Training Costs (€)	0	8,471,401	1,592,854	355,364	480	13,760	0	*10,433,859*	*1,490,551*
Total area supported (Ha's)	236,261	334,830	320,794	331,574	333,212	333,045	257,887	*N/A*	*306,800*
No. of paid participants	15,914	23,185	22,042	22,901	22,295	22,742	16,465	*N/A*	*20,792*
No. of Carbon Navigators completed	0	23,553	23,650	21,868	23,163	23,028	18,053	*133,315*	*19,045*
No. of BDGP reports issued to farmers	27,493	23,844	99,042	46,074	24,099	57,616	36,433	*314,601*	*44,943*
Mean Payment per Participant (€)	1,822	2,191	2,006	1,955	1,859	1,825	1,929	*N/A*	*1,948*
Mean Payment per Hectare (€)	123	152	138	135	124	125	123	*N/A*	*132*

Table Two: Key descriptive statistics from the BDGP (2015-2021). Source: DAFM*; Note: Items marked with an asterisk (*) indicate expenditure includes EU funding at 53% rate; years refer to calendar year; No. BDGP Reports increased significantly in 2017 due to being issued quarterly. Mean payments per hectare/participant exclude training costs. Mean averages calculated by dividing sum total payments by the number of participants or hectares overall in the period 2015-2021.*

Participant Characteristics

BDGP are usually participants in GLAS, which is the key agri-environment scheme, with 61% of BDGP participants recorded as being in GLAS at the end of 2019. This supports the assumption that suckler farming in Ireland is generally carried out on an extensive pasture-based system. This type of farming has multiple environmental co-benefits in relation to maintaining landscapes and biodiversity. Similarly, 65% of BDGP participants were in the pilot BEEP scheme, and 85% of BEEP participants were enrolled in BDGP, in 2019; this highlights the complementarity of the schemes, with the performance-based BEEP animal weight data supplementing the genetic information from BDGP to inform farm decisions.

24,200 Cattle Rearing (CR) or Cattle Other (CO) farms represented in the Teagasc National Farm Survey (NFS) [13] (NFS) were enrolled in BDGP in 2020, equivalent to 45% of the underlying NFS population of 54,000 farms; 69% of NFS BDGP farms represented in the data were classified as CR, with a larger fall in farms within the CO system during the period. CO farms are more likely to be beef finishing enterprises and therefore not necessarily enrolled in schemes such as BDGP that focus on breeding management. This descriptive data shows that BDGP participants tend to be marginally younger than their non-BDGP counterparts with an average age of 55 years for participants on Cattle Rearing (CR) Farms and 56 years on Cattle Other (CO) farms on average over the period 2015-2020. This compares to 60 years and 59 years respectively for non-BDGP participants. Given the differences between both farming enterprises, and the greater likelihood of participation in the BDGP from CR farms given the focus on breeding management, the descriptive statistics provided below are set out separately for both farm types.

Cattle Rearing Descriptive Data

CR farms enrolled in the BDGP generally farm larger areas, hold higher numbers of livestock and produce higher levels of output with associated higher incomes. The average utilisable agricultural area (UAA) was 33 ha. among BDGP participants in 2020, vs. 28 ha. for non-BDGP participants.

The percentage difference between BDGP and non-BDGP CR farms' mean values – in terms of costs, output, profitability and income – are significantly higher on average according to the Teagasc 2015-2020 summary data. However, it must be noted that participation in the BDGP does yield a payment not available to non-participants which contributes to income. Figure Two shows the difference across economic indicators between BDGP and non-BDGP participants among CR NFS farms. Further, Figure Three shows the distribution of CR NFS farms across Family Farm Income brackets in 2020 compared to 2015, highlighting differences by cohort.

[13] Summary statistics provided by Teagasc upon request to provide a descriptive overview of selected data for farmers participating in BDGP versus non-participants. However, this data should not be inferred as a reflection on the performance of BDGP as there are a myriad of factors that drive farm performance. The 2020 Teagasc NFS is a representative sample of 836 farms with a Standard Output of at least €8,00 per annum – an economic threshold equivalent to four dairy cows, five hectares of wheat or eleven suckler cows – representing over 93,000 farms nationally. Other 'Small Farms' are generally less likely to participate in schemes such as BDGP. Cattle Rearing farms are also naturally more likely to participate in BDGP.

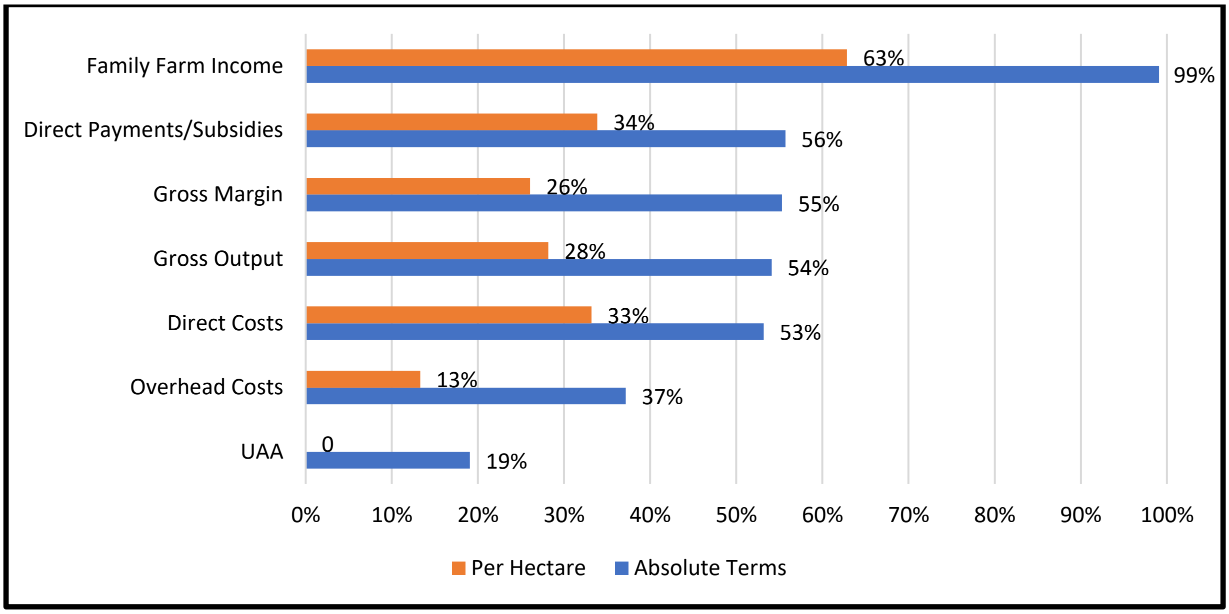


Figure Two: 2015-2020 Average difference in mean values between BDGP and Non-BDGP Cattle Rearing Farms. Differences expressed for absolute values and values relative to land use (per hectare). Source: Author's Calculations based on Teagasc NFS data. Note: There is no difference in UAA per Hectare as UAA is the denominator in the per hectare difference calculations.

In 2020, NFS CR farms that did not participate in BDGP tended to earn Family Farm Income of less than €20,000 almost exclusively on average; by comparison, 14% of NFS CR farms overall and 19% of NFS CR farms enrolled in BDGP earned more than €20,000 in FFI. This difference in income distribution has widened since 2015, with the proportion of non-BDGP farms earning less than €10,000 FFI per annum rising from 67% to 78%. On the contrary, a lower proportion of CR farms enrolled in BDGP earned less than €10,000 in 2020 than did so in 2015.

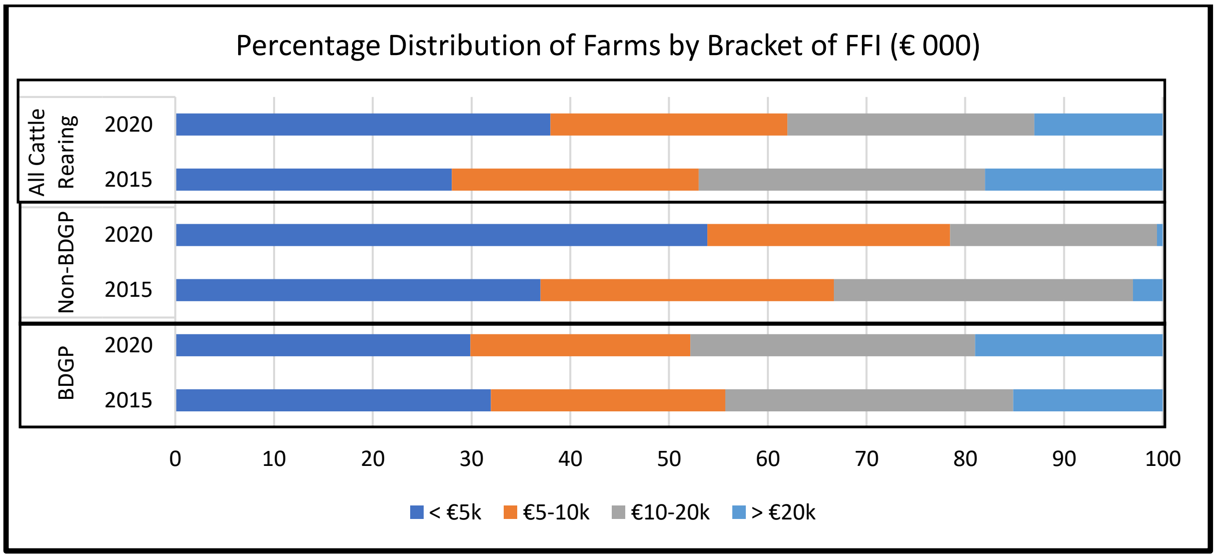


Figure Three: Distribution (%) of NFS Cattle Rearing farms, by bracket of Family Farm Income, in 2015 and 2020. Source: Teagasc NFS data.

The NFS data on CR farms also shows households of those enrolled in BDGP are larger, more likely to have an individual below the age of 24 or aged 25-44, and less likely to be in receipt of unemployment or pension payments. The households of farms enrolled in BDGP are also more likely to have off-farm employment (overall, from the farm holder or their spouse).

Overall, this NFS data indicates greater social (demographic) and economic viability among CR farms enrolled in the BDGP. This could indicate that farms which have larger agricultural areas, greater levels of livestock and generate higher output are more likely to engage with schemes of this type, to implement the necessary technologies and management practices, and could be more likely to continue to farm into the future.

Cattle Other Descriptive Data

There are similar trends to CR farms seen among CO farms, with significant distinctions in scale and viability between BDGP farms and non-BDGP participating farms. It's also important to note that many CO farms may be more likely to operate a beef finishing enterprise that tends to buy in stock and less likely to be involved in breeding related decisions, so therefore would not be expected to participate in a scheme such as the BDGP, and therefore would be reflected in the non-BDGP participants statistics presented here.

The percentage difference between BDGP and non-BDGP farms' mean economic performance values also reflect the positive differences as seen on CR farms. Again, it must be noted that participation in the BDGP does yield a payment not available to non-participants which contributes to income.

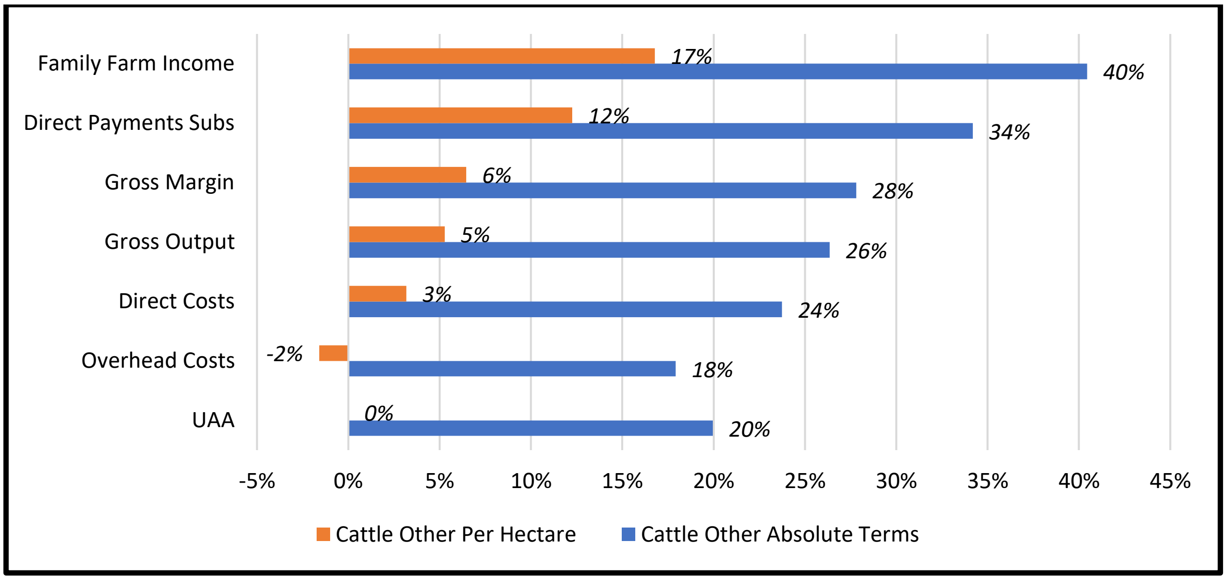


Figure Four: 2015-20 Average difference in values between BDGP and Non-BDGP Cattle Other NFS Farms. Differences expressed absolutely and per hectare. Source: Author's Calculations based on Teagasc NFS data.

CO farms enrolled in the BDGP generally farm larger areas, hold higher numbers of livestock and produce higher levels of output with associated higher incomes. The average UAA from 2015-2020 was 41 ha for BDGP participants vs 34 for non-BDGP participants. In 2020, NFS CO farms that did not participate in BDGP tended to earn Family Farm Income of less than €20,000, with 80% falling below this threshold; this compares to 27% of NFS CO farms overall and 43% of NFS CO farms enrolled in BDGP who generated more than €20,000 in FFI. The difference in income distribution has improved slightly since 2015, with the proportion of non-BDGP CO earning less than €10,000 FFI per annum falling from 60% to 52% among this cohort. Among those enrolled in BDGP, this figure has remained unchanged at 43% over the same period, with the overall CO rate also relatively unchanged at approx. 50%.

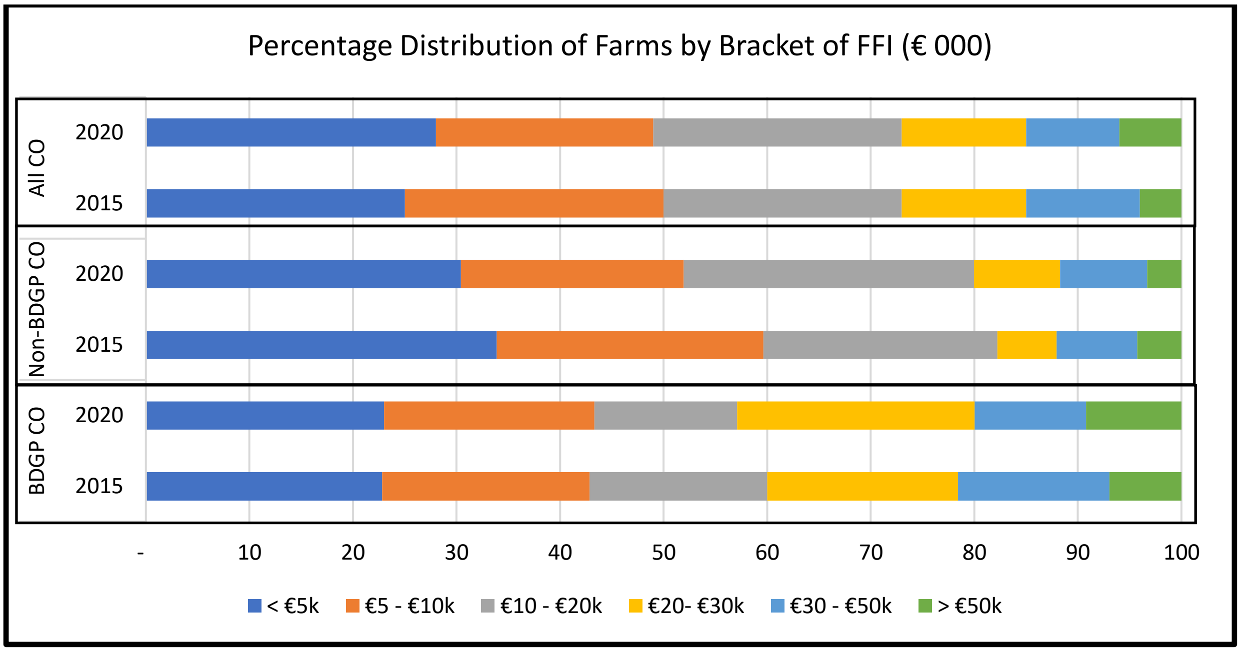


Figure Five: FFI Distribution of Cattle Other NFS Farms in 2015 and 2020. Source: Teagasc NFS data.

Genetic Trends 2015-2021

A key feature of the BDGP training programme is to persuade farmers to engage with the ICBF website to search for higher rated stock to improve the genetic merits of their herd. Figure Six shows an increasing trend in farmers utilising the website, with annual user sessions up 120% (880,000) by 2020 compared to 2015. There has also been a steady increase in the searches for Beef Bulls as more farmers become aware and familiar with the database.

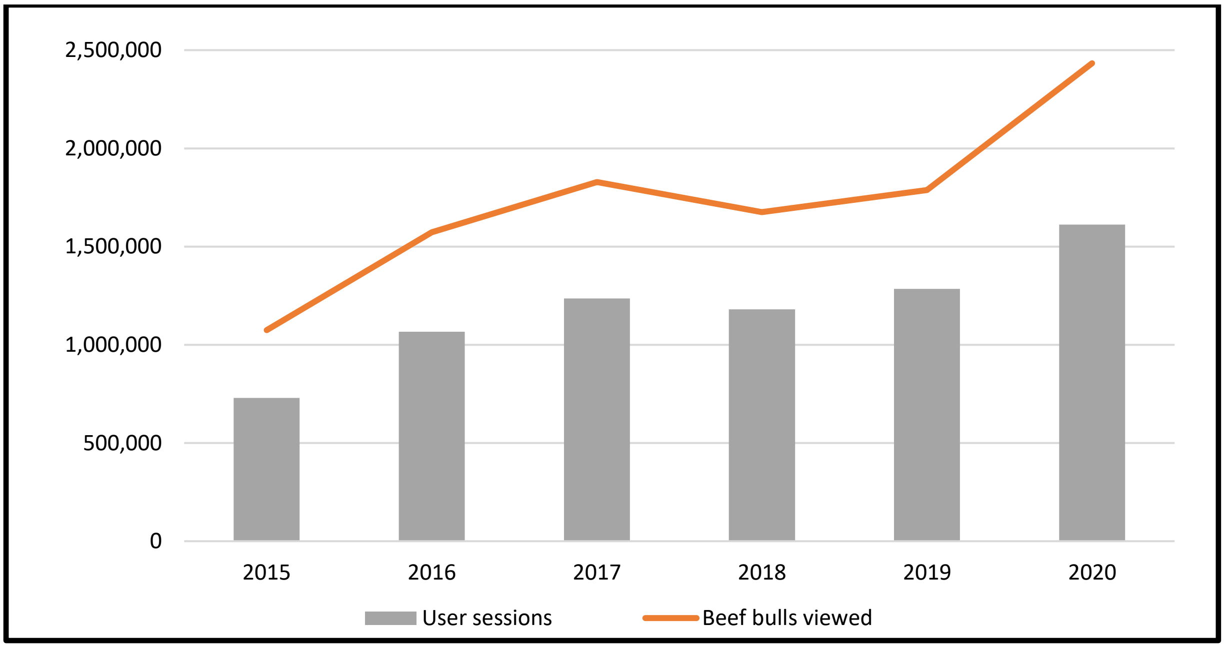


Figure Six: User Sessions and No. searches per year for Beef Bulls on ICBF website 2015-20. *Source: ICBF*

The data on outcomes indicates a positive impact has emerged in the performance of enrolled animals, although the true benefits will accrue a longer-term period as the cumulative gains are realised (Amer et al. 2007).[14] Given the low replacement rate in cattle (i.e. each cow has just one calf per year as opposed to sheep or pigs which can have more), the genetic gain is slower, but the actions and structures taken now will drive these gains in the future as a result of the iterative, cumulative and permanent nature of genetic gains that will emerge. The genetic improvement to date is represented by the Replacement Index, a monetary measure based on a weighted composite of animal traits[15].

Feature Box One: Replacement and Terminal Indices

The €urostar Replacement Index, split into two weighted composites which track Replacement (Maternal) and Terminal traits, is a measure of the relative value of cows based on the National Herd Dataset. These live-updated indices inform on-farm breeding decisions by supporting producers.

The Terminal Index is comprised of carcass traits (57%), calving traits (25%), feed intake (16%) and docility (2%). This is based on the objective of lowering costs of production in terms of ease of calving, low mortality, shorter gestation periods, and achieving optimal carcass weight and traits. This aims to predict the profitability of animal's progeny in terms of liveweight, carcass conformation and finishing for slaughter.

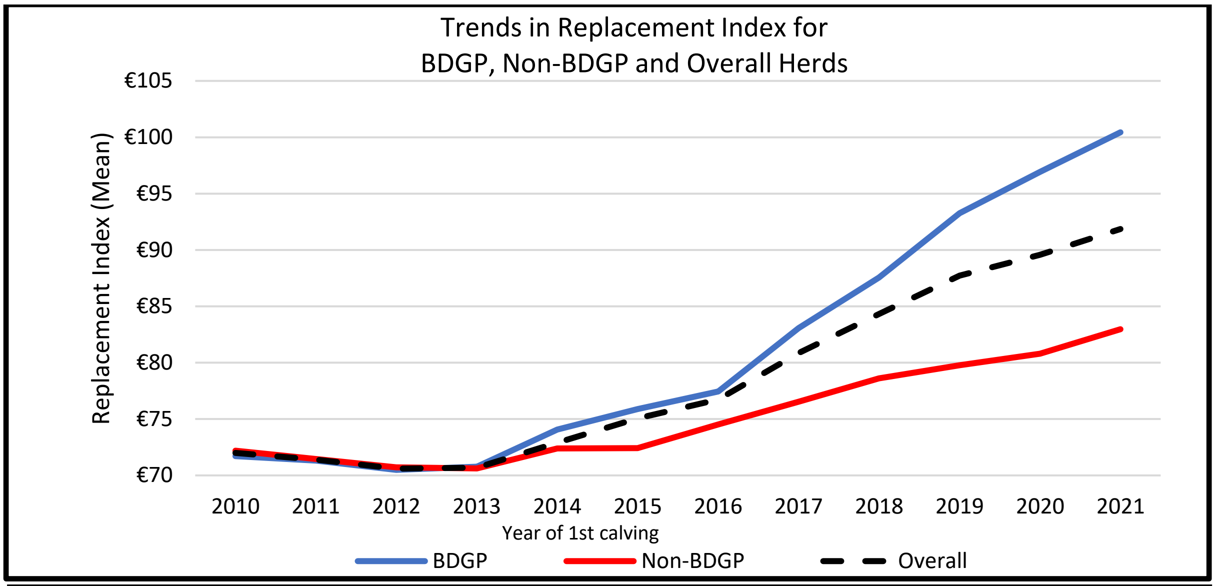
The Replacement Index is comprised of cow (71%) and calf (29%) traits. Cow traits includes, e.g., maternal calving difficulty (6%), age at first calving (6%), survival rates (8%), liveweight (14%), docility (4%). The Replacement Index estimates the suitability of an animal's daughter, with high-rated dams (which have superior milk traits, smaller calving intervals and superior cull cow weights) producing low-maintenance suckler cows (which require lower feed intake and reach a higher carcass weight with greater carcass conformation etc.). A breakdown the indices' composition is included in the appendix.

The trends in the replacement index have been steadily increasing for BDGP herds over the period of the BDGP. A significant positive externality of the BDGP is the spill-over effect as non-participants also access information on genetic merit and the increased value of herds affects cows of the same genetic line to improve their breeding decisions. Figure X shows the trends for first time calving females before and after the introduction of the BDGP in 2015; while Figure Y shows the year-on-year change in the mean value of the Replacement and Terminal Indices, with both growing in recent years, highlighting the reversal of the trend of reducing maternal traits over time prior to BDGP. This is important given increases in Replacement Index value provide a significant environmental dividend, compared to the predominantly market value benefits provided by Terminal Index gains. The focus in the replacement index on maternal traits generates a relatively larger environmental efficiency dividend, in terms of GHG mitigation for a given increase in index value, compared to the terminal index. A 2018 paper by Quinton et al estimated that for every €1 increase in Replacement (Terminal) Index value, 0.81 (0.005) KG CO2e is saved per year – a 20-fold marginal difference[16].

[14] Amer, P. R., Nieuwhof, G. J., Pollott, G. E., Roughsedge, T., Conington, J. and G. Simm (2007) "Industry benefits from recent genetic progress in sheep and beef populations" *Animal* **1**(10): 1414-1426.

[15] See appendix for full details of the traits which inform the indices and their relative weightings.

[16] Quinton, C. D., Hely, F. S., Amer, P. R., Byrne, T. J. and A. R. Cromie (2018) "Prediction of effects of beef selection indexes on greenhouse gas emissions" *Animal* **12**(5): 889-897.



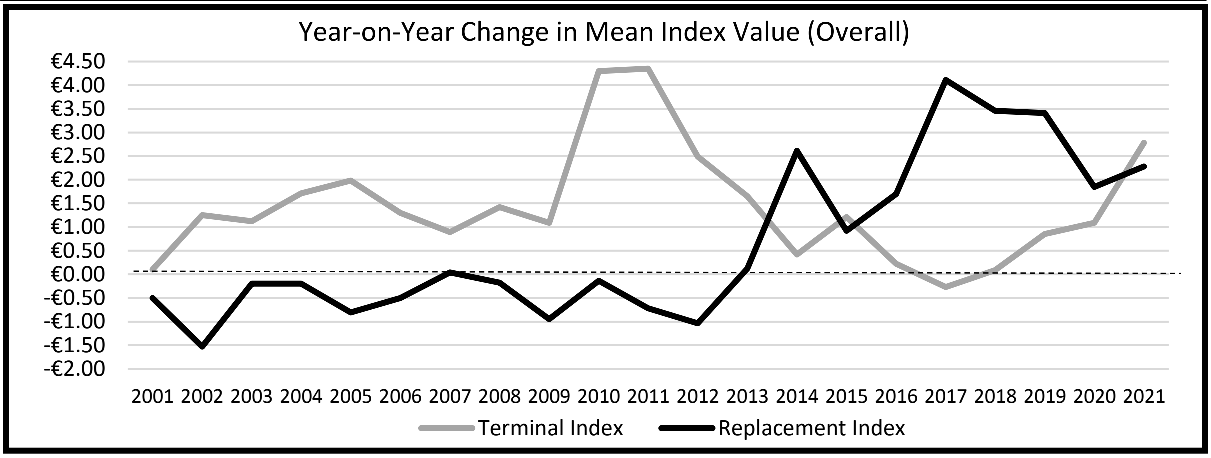


Figure Seven: Genetic trends in the Replacement Index (2010-2021); and year-on-year changes in the Replacement and Terminal Indices (2000-2021). Source: ICBF.

Below, the percentage of replacement females in Herds that are rated between 4-5 stars (Rep Index value > €74) are graphed by year of first calving for BDGP and non-BDGP herds, as well as overall. The threshold for a four-star cow was €74 when BDGP began in 2015, representing a locked baseline.

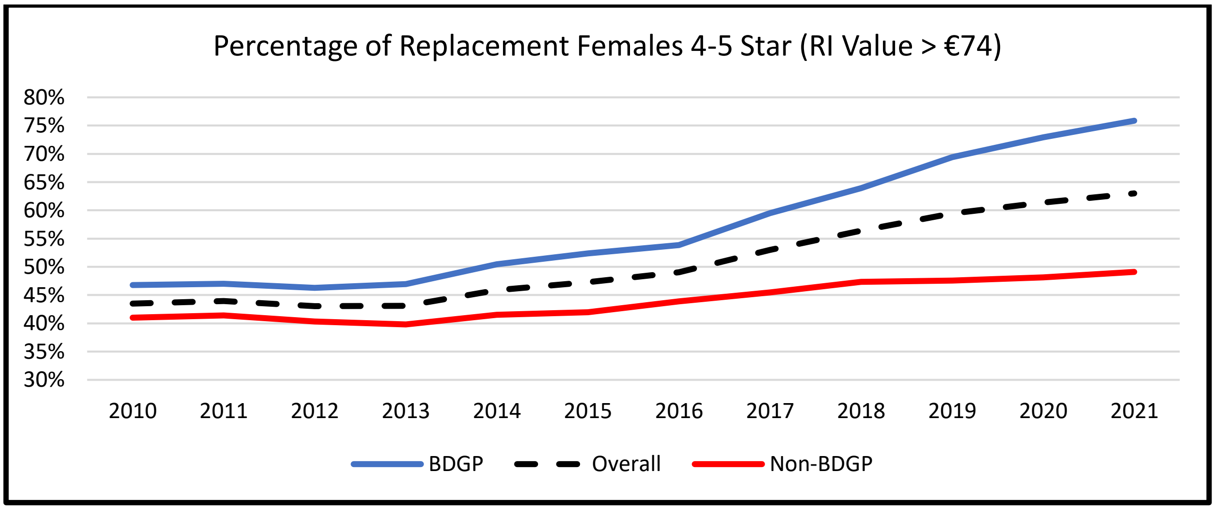
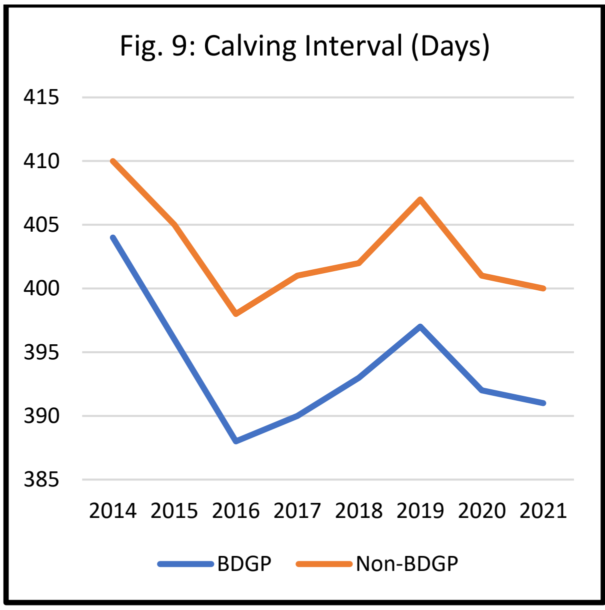


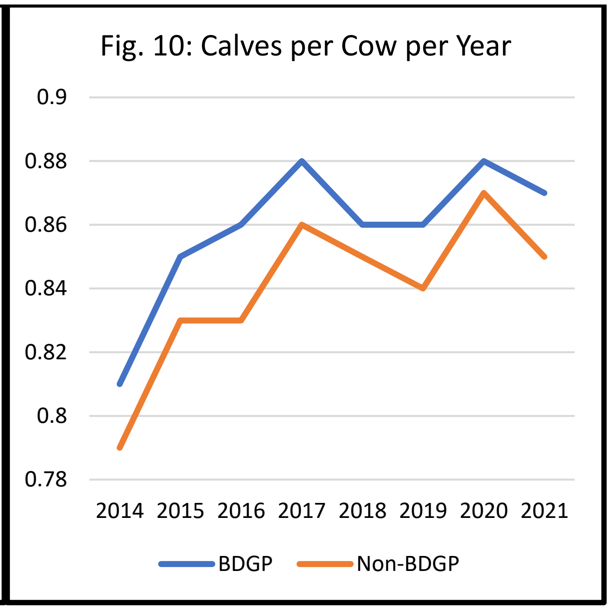
Figure Eight: Trends in Replacement Index Value among BDGP (left) and non-BDGP (right) herds; and percentage of replacement females in herds rated as four or five stars in BDGP (left) and non-BDGP (right) herds 2010-2021. Source: ICBF.

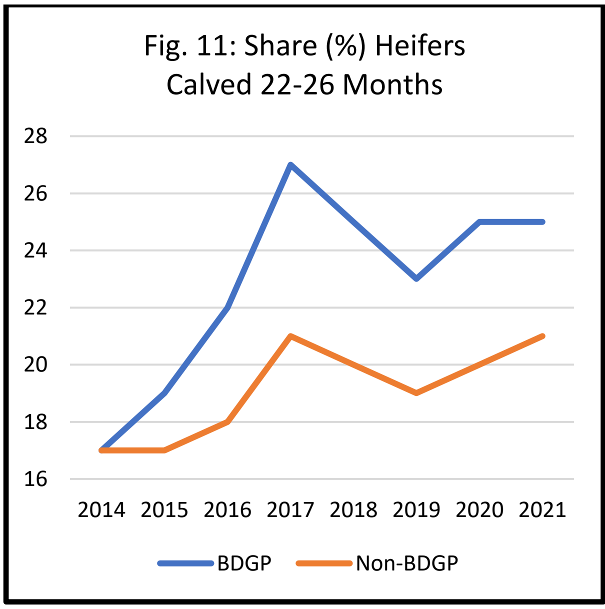
Key Performance Indicators

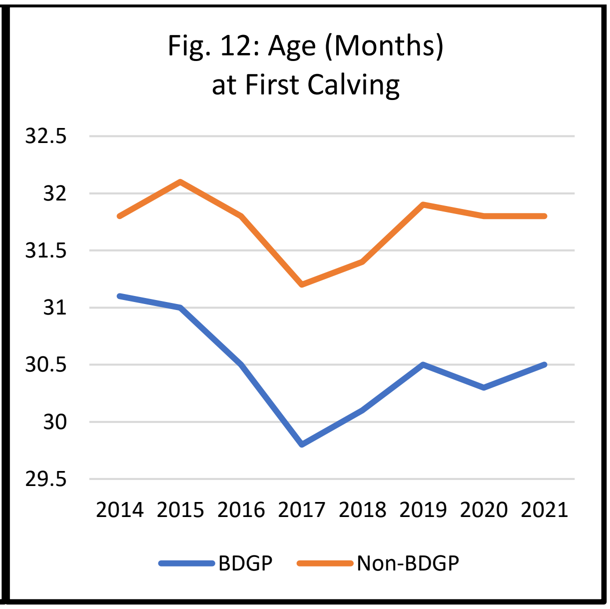
The data on Key Performance Indicators (KPIs) and Sustainability Metrics also indicate that animals enrolled in the BDGP are breeding younger first-time calvers, have reduced average calving intervals, record improved weights for weanlings and lengthier grazing seasons (weather permitting). These favourable gaps between BDGP and non-BDGP herds have also generally increased across all indicators compared to 2014, pre-BDGP, also. In addition, these indicators have also improved among non-BDGP herds, suggesting positive spill-over effects; however, the rate of improvement has not been to the same level as those among BDGP herds as outlined in Table Three.

Overall calving intervals have shortened, the number of calves per cow per year have increased, the percentage of heifers calved at 22-26 months of age has increased and the age of first calving has decreased, all at higher rates for BDGP participating herds on average.









Figures 9-12: Key Performance Indicators among BDGP and non-BDGP herds 2014-2021. Source: ICBF.

Year / Cohort	Calving Interval (Months)		Calves per Cow per Year		Share (%) of Heifers Calved between 22-26 Months		Age (Months) at First Calving		Share (%) with Sire Recording		Calving Difference		Share (%) with AI-Sired Calves	
	BDGP	Non	BDGP	Non	BDGP	Non	BDGP	Non	BDGP	Non-BDGP	BDGP	Non-BDGP	BDGP	Non-BDGP
2014	404	410	0.81	0.79	17	17	31.1	31.8	79	53	83	54	27	19
2015	396	405	0.85	0.83	19	17	31	32.1	81	54	85	54	27	20
2016	388	398	0.86	0.83	22	18	30.5	31.8	93	54	97	53	29	20
2017	390	401	0.88	0.86	27	21	29.8	31.2	90	57	94	57	30	20
2018	393	402	0.86	0.85	25	20	30.1	31.4	89	56	93	57	30	20
2019	397	407	0.86	0.84	23	19	30.5	31.9	90	56	93	56	29	20
2020	392	401	0.88	0.87	25	20	30.3	31.8	91	54	93	55	29	19
2021	391	400	0.87	0.85	25	21	30.5	31.8	90	51	93	53	29	19

Table Three: Key Mean Average indicators from BDGP herds 2014-2021[17]

While the table above shows there have been improvements among both BDGP and non-BDGP herds since 2014, the table below also shows that the gap between BDGP and non-BDGP herds has also widened since BDGP was introduced. There has been further divergence beyond the baseline, seen across almost all key performance indicators. The gap has only remained constant in the case of calves per cow per year where there have been improvements for both BDGP and non-BDGP herds at a similar rate of improvement across the years. The charts on the following page also illustrate this.

2014-2021 Change	Calving Interval	Calves per Cow per Year	Share (%) of Heifers Calved 22-26 Months	Age at First Calving	Share (%) with Sire Recording	Calving Difference	Share (%) with AI-Sired Calves
BDGP	-13	0.06	8	-0.6	11	10	2
Non-BDGP	-10	0.06	4	0	-2	-1	0
Difference BDGP vs. non-BDGP	-3	0	4	-0.6	13	11	2

[17] The criteria for a herd to be included in the national statistics presented here include the following:

Calving Interval	≥ 10 cows calved with a calving interval (second calvers +)
Calves per Cow per Year	≥ 10 cows calved
% Heifers Calved 22-26 Months	≥ 3 heifers calved

Table Four shows that top-rated (5-star) animals outperform others in productivity and carbon efficiency. In other words, these cows produce more output with lower levels of input and have lower carbon footprints. The differences between the top 20% of herds and the bottom are significant with more modest variation within the other cohorts.

KPI / Sustainability Metric	Source	Standard Deviation	Bottom 20%	21-40%	Average	61-80%	Top 20%	Difference Top vs. Bottom 20%
Avg. Replacement Index (€)	ICBF (BDGP)	-	42	63	80	96	122	80.0
Cow Liveweight (KG)	BEEP-S	56	689	670	664	656	652	- 37.2
Calf 200-Day Liveweight (KG)	BEEP-S	34.8	280	280	285	286	287	7.1
Weaning Efficiency	BEEP-S	5.5	40.8	42	43	43.9	44.3	3.5
Calving Interval (Days)	ICBF (BDGP)	28.7	399	394	390	385	388	- 11.4
Calves per Cow per Year	ICBF (BDGP)	0.12	0.85	0.88	0.89	0.91	0.91	0.06
Profit per Livestock Unit (€)	Teagasc	-	207	219	238	244	262	55.0
Carbon Footprint (KG CO2e/KG Beef)	Bord Bia	1.82	13.16	12.97	12.82	12.42	11.91	- 1.3

Table Four: Comparative analysis – €uro star System (Replacement Index) Quintiles *Source: ICBF*

The Weaning Efficiency is an important indicator of performance for the animals involved. Weaning Efficiency is the percentage of a cow's own weight from her calf at 200 days or age and was a key metric captured under the BEEP-S scheme. The lower weight of the cow is particularly relevant for the policy objectives as heavier cows require additional inputs such as feed which incurs additional costs for farmers due to increased maintenance costs and higher levels of GHG emissions and other environmental pressures for heavier animals. Table Five outlines some key indicators from ICBF BEEP-S data which correspond to the BDGP stars:

Star Rating (Quintile)	200-day Calf Average Daily Gain (ADG) (KG)	Calf Age at Slaughter (Days)	Days from Weaning to Slaughter	Carcass Weight (KG)
5	1.57	509	311	392
4	1.38	530	324	383
3	1.28	551	342	375
2	1.19	574	363	367
1	1.01	612	402	352
Difference 5 vs. 1 Star (No.)	0.56	-103	-91	40
Difference 5 vs. 1 Star (%)	55	-17	-23	11

Table Five: Irish Cattle Breeding Federation Weaning Report 2021. Source: ICBF. *Notes: Table based on 33,000 cow/calf pairs; ADG refers to Average Daily Gain, which is the amount of weight the calf gains from feed; Weaning efficiency calculated as calf weight divided by cow weight multiplied by 100.*

The focus on weaning efficiency must be balanced with animal health and welfare concerns. The collection of performance related data, and interaction with other policies provides the necessary basis to ensure these concerns can be minimised. Genetics can also contribute to animal health as one part of an overall strategy for disease eradication due to improved resilience[18].

Carbon Navigator

The Carbon Navigator as a tool was utilised for 'high level' monitoring of progress at farms. It familiarised participating farmers with the need to observe and improve their environmental performance, without requiring the more intensive analysis available under the Bord Bia Carbon Footprint Model, although there are a significant cohort of BDGP participants that also complete the Carbon Footprint Model outside the requirements of the BDGP. ICBF data received for the Carbon Navigator are presented in Table Six:

Metric	First year	Final year	Change *(inc statistical sig).*
Suckler cows; Days at grass	213	216.5	+3.5 *($p<0.001$)*.
Suckler calves; Days at grass	216	227	+11 *($p<0.001$)*.
Urea usage; Tonnes/farm	0.23	0.49	+0.26 *($p<0.001$)*.
Fertiliser usage; Tonnes of CAN + Compound N	6.17	6.02	-0.15 *($p<0.05$)*.

Table Six. Trends in key metrics as recorded as part of Carbon Navigator. Source: ICBF.

As the table illustrates all of the key environmental measures are improving with the results deemed statistically significant at the 5% level for fertiliser usage, and 0.1% level for the others. These positive trends highlight the benefits of undertaking the Carbon Navigator supported by relevant Knowledge Transfer activities and recording the annual data.

A future iteration of the programme could adopt these metrics as an integral component of the annual reporting process to further underpin the key objective of the scheme to reduce the carbon footprint of production. Building on the awareness developed through the BDGP will ensure that farmers continually improve their environmental performance in tandem with their genetic merit gains from the scheme.

Environmental Impact

The precision of GHG emission measurement is highly complex with some of the more relevant scientific studies including Murphy et al. (2013), Quinton et al (2018), Beauchemin et al. (2011)[19] and Wall et al. (2010)[20] finding positive impacts on the intensity of emissions per unit of output for genetic gains. The cumulative effect of these reductions in the emissions from the national herd will make a substantial contribution to GHG related targets as the genetic gain increases over time.

The overall environmental impact, in terms of GHG output, can be separated into absolute emissions and the emissions intensity of production. Gross emissions refer to the total emissions from the suckler cow herd, and is calculated here as the number of Other (Non-

[18] Berry, D. et al (2011) *Genetics of animal health and disease in cattle* in Irish Veterinary Journal, Issue 64, Article 5.
[19] Beauchemin, K. A., Janzen, H. H., Little, S. M, McAllister, T. A. and S. M. McGinn (2011) "Mitigation of greenhouse gas emissions from beef production in western Canada – Evaluation using farm-based life cycle assessment" *Animal Feed Science and Technology* **166-167**: 663-677.
[20] Wall, E., Ludemann, C., Jones, H., Auldsley, E., Moran, D., Roughsedge, T. And P. Amer (2010) "The potential for reducing greenhouse gas emissions for sheep and cattle in the UK using genetic selection" funded under DEFRA project: *Would livestock breeding goals change if carbon and nitrogen efficiency rather than economic efficiency were the priority objectives?* IF0182.

Dairy) Cows multiplied by the mean baseline level of emissions per cow per year, estimated here as 3.4755 Tonnes of CO^2eq per annum. Emissions intensity is the Kg CO^2e generated per Kg of meat, an indication of the emissions efficiency with which meat can be produced. Quinton et al (2018) estimated the emissions intensity of Irish beef at 19.763KG CO2eq per KG beef produced at an aggregate level[21]. Improvements in genetic merit enable lower emissions intensity through greater efficiency, increasing beef output while reducing emissions per KG beef produced – i.e. a double benefit in greater output from lesser GHG emissions.

NFS Data on Environmental Outcomes

Annual descriptive summary data from the Teagasc NFS over the period 2015-2020, show that although the overall emissions profile from beef system farms enrolled in BDGP is higher than those not in the BDGP, the emissions efficiency of these farms is generally superior and has improved at a faster pace. This reflects the relatively larger scale of farms that tend to participate in BDGP, but also reflects that those are the farms making the largest genetic gains which will yield the largest overall benefit for mitigation potential.

CR and CO farms enrolled in BDGP had the lowest three-year average emissions relative to output (lowest KG CO^2e emitted per KG Liveweight Beef produced) despite having the highest absolute total emissions, indicating efficiency gains. These efficiencies are likely derived from the scale, higher investment levels and higher genetic merit, meaning lower emissions for a given level of beef output or economic value. The higher absolute emissions reflect greater beef output from these farms which would tend to be the more economically viable farms, but with unit level improvements also reflecting environmental efficiency.

Percentage (%) Difference between BDGP vs. Non-BDGP 2018-2020 Three-Year Average	Cattle Rearing	Cattle Other
Total Agricultural GHG Emissions per Farm (T CO2e)	+56	+21
Ag. GHG Emissions per kg live-weight beef (KG CO2e)	-5	-6
Ag. GHG Emissions per € Output (KG CO2e)	-22	-7

Table Seven: Average % Difference within 2018-2020 between BDGP and non-BDGP farms in emissions (absolutely and relative to output) by Farm Type. Source: Author's Calculations based on Teagasc NFS Data.

Total farm emissions grew among all CR farms, but to a lesser extent among those in BDGP, while CO farms absolute emissions fell from a higher level for those in BDGP and grew among those not in BDGP. Wider environmental impacts also differ by cohort. For example, Ammonia (NH3) emissions per farm grew among CR farms, but to a lesser extent for those enrolled in BDGP (12%) compared to those not enrolled in BDGP (30%). Ammonia emissions fell among CO farms, but by a larger amount on BDGP farms (6%) compared to non-BDGP farms (0.2%) over the period. Overall, total emissions grew at a slower pace in absolute terms on BDGP farms – or even decreased in the case of CO BDGP farms, year-on-year within the period on average – and emissions efficiency generally improved at a faster average rate among BDGP herds in the NFS data, as seen below.

[21] This was calculated using a baseline assumption of approx. 957,000 cows and predicted production level of 175.86 KG per suckler cow at an aggregate level.

Farm Type	Total Ag. GHG Emissions per Farm	Ag. GHG Emissions per KG live-weight Beef	Ag GHG Emissions per € Output
BDGP CR	2.7	-1.5	-0.9
Non-BDGP CR	7.1	-1.1	4.9
BDGP CO	-1.0	-1.0	-1.3
Non-BDGP CO	1.5	-1.0	-2.7
All Cattle Farms	*0.6*	*-1.2*	*-0.3*

Table Eight: Average Year-on-Year % Change within 2016-2020. Source: Author's Calculations based on Teagasc NFS data. It should be noted that among non-BDGP Cattle Rearing farms, a 28% increase in GHGs per € output in 2017-18, and a 58% increase in total GHGs in 2015-16, are outlier values which increase the trend estimates and may reflect a low sampling N.

Emissions Savings Achieved in the Irish Beef Sector 2015-2021

Data from the ICBF shows that the beef herd has improved its genetic merit in recent years, with the BDGP credited with reversing a previously decreasing trend in maternal traits. When this gain is added to those achieved in terminal traits, it portrays an upward trajectory which is predicted to continue generating additional value to the replacement index over the next decade and beyond. These positive trends in genetic merit have a direct impact at reducing gross emissions from the sector, as evidenced in the Quinton et al. (2018) study. This study showed that:

- for each €1 increase in the maternal index, emissions would fall by 0.81kg CO^2e. In addition,
- for each €1 increase in the terminal index, emissions would fall by 0.005kg CO^2e per cow.

In the paper, the authors then sought to take the level of genetic trend being achieved in the Irish suckler beef herd in 2016 (€1.67/cow/year) and present this in terms of reductions of gross emission, with an estimated reduction in total GHG emissions of 0.4% after the first 5 years of the program, increasing to 1.5% after 20 years. However, once compared with current trends among BDGP herds, gross emissions have actually reduced by 1.05% at 2021, significantly higher than the 0.4% presented in the paper (see table below). This is due to the increase in genetic gain now being achieved as a result of BDGP.

To highlight this point, the Replacement Index increased by €0.80 between 2015 and 2016, but the rate of increase averaged €4.60 within 2017-2021, which is significantly higher than the €1.67/year predicted in the Quinton et al. paper. This is also significantly higher than the €2.60 year-on-year gain on average achieved among non-BDGP herds within this period, which reflects the positive spill-over effect.

Expressing these emissions savings in terms of the level of reduction in total GHG output, these genetic improvements equate to a reduction in gross emissions of 18.8 Kilo-Tonnes of GHGs among BDGP herds. This is equivalent to a reduction in actual suckler cow numbers of some 5,400 cows that would have been produced if the genetic merit remained at 2015 levels.

Year	2015	2016	2017	2018	2019	2020	2021
Total Cows	514,559	530,285	539,370	534,196	524,944	522,065	488,625
Replacement Index Value (€, Mean)	75.10	75.90	80.50	85.30	90.50	94.80	98.80
Rep Index Gain (Cumulative * 2)	-	1.60	10.80	20.40	30.80	39.40	47.40
Terminal Index Value (€, Mean)	57.90	59.40	59.70	59.90	62.20	65.80	69.60
Terminal Index Gain (Cumulative * 2)	-	3.00	3.60	4.00	8.60	15.80	23.40
Kg CO2eq Saved per € Increase in Index							
Replacement (Maternal Traits)	-	*0.81*	*0.81*	*0.81*	*0.81*	*0.81*	*0.81*
Terminal	-	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*	*0.005*
KG CO2eq Saved per Cow per Year vs. 2015	-	1.311	8.766	16.544	24.991	31.993	38.511
KG CO2eq Saved for All Cows in Given Year	-	695,204	4,728,117	8,837,739	13,118,876	16,702,426	18,817,437
Expressed in MT CO2eq	-	*0.0007*	*0.0047*	*0.0088*	*0.0131*	*0.0167*	*0.0188*
Expressed in cow equivalents	-	*200*	*1,360*	*2,543*	*3,774*	*4,805*	*5,414*
Expressed as a % of Total GHG output of All Cows in Given Year	-	*0.04%*	*0.26%*	*0.49%*	*0.73%*	*0.93%*	*1.05%*

Table Nine: Reduction in GHGs achieved due to increases in Genetic Merit among BDGP herds between 2015-21. KG CO2eq saved per Euro increase in Index value derived from Quinton et al (2018). Source: ICBF. Note: Gains in Index Value are measured as the cumulative gain since 2015, multiplied by two to reflect genetic gain for both the dam and its progeny. One cow equivelant is measured as 3.476 Tonnes of CO2e, which is the mean baseline emissions per cow per year.

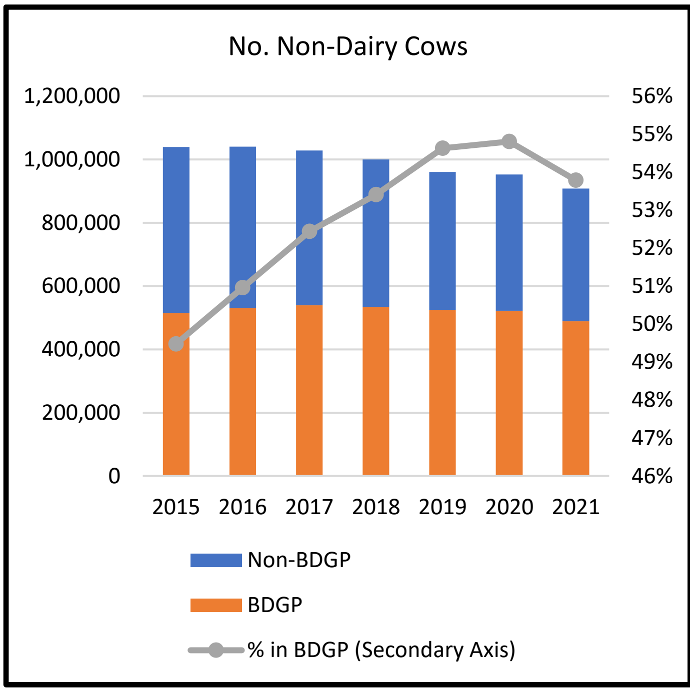
Using a weighted average of both terminal and maternal index trends, gross emissions have decreased by 7.9 KG CO^2e per cow per year since 2015 on average, meaning the average cow enrolled in BDGP emits 38.5 KG less CO^2eq per year today than would have been the case if genetic merit had held constant at its 2015 level. This sums to a significant contribution at a population level to overall lower emissions over time, and one which will continue to increase over time as these genetic improvements are cumulative and permanent.

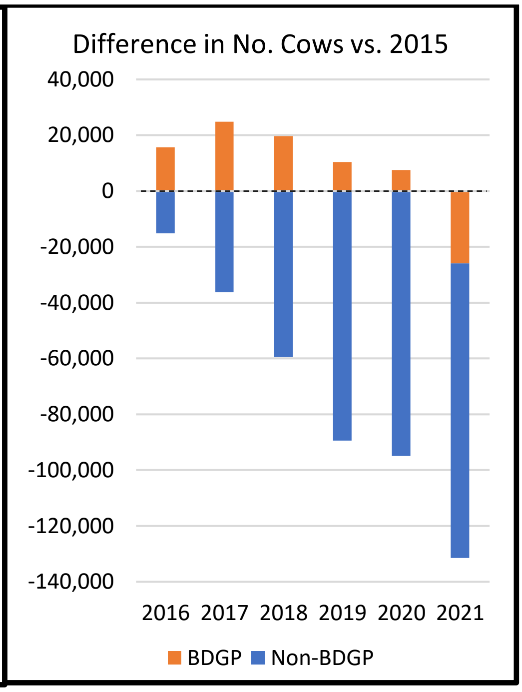
Total emissions fell from 3.61m tonnes of CO^2e in 2015 to 3.12m tonnes of CO^2eq in 2021 (-13.6%), and while the majority of this fall was due to population decline (mainly in non-BDGP herds), the genetic improvements realised for BDGP participants through the structures and actions implemented ensure that those beef producers enrolled are producing a lower emitting product. The total reduction in GHG emissions among herds in BDGP is estimated at 109 KT CO^2eq, or 6.1%, compared to 2015.

The GHG emissions of farms enrolled in BDGP are higher in absolute terms compared to non-BDGP farms, however these farms also have greater economic viability, and therefore more likely to continue farming into the future, which will ultimately yield greater GHG emissions efficiency. This is true both in terms of emissions per cow and emissions per Euro of economic value produced, due to the higher genetic merit of livestock which accumulates over time and represent permanent gains.

The number of Other Cows held on farms not enrolled in BDGP have fallen significantly between 2015-2021, while the decline among farms enrolled in BDGP has been more modest; as a result, absolute emissions savings have been largest among non-BDGP farms. While the proportion of cows held on BDGP and non-BDGP farms was roughly equal in aggregate terms in 2015, this has changed significantly since, with BDGP farms now holding 54% of the 0.909m cows overall (see charts below). This compares to just under 50% of 1.04m cows in 2015. The year-on-year change in cows averaged -3.9% within the non-BDGP cohort and -0.8% for the BDGP cohort. It must be noted that the higher rate of retention of stock among BDGP farms is likely linked to the replacement requirements of the scheme. The significant reduction in BDGP cows year-on-year in 2021 of 33,450 (6.4%) is likely linked to several factors, including:

- the end of the five-year BDGP contract entered into in 2015;
- a high cross-participation level with the BEAM scheme, which included a condition for participants to reduce their cow numbers by 5%;
- farmers being able to achieve the same level of beef output for a given number of cows due to improvements in efficiency; and
- continued profitability challenges within the sector.





Figures Thirteen and Fourteen: Number, and Change in, Cows among BDGP and non-BDGP herds 2015-2021. Source: ICBF.

The graphs below highlight the changes in emissions compared to 2015, by BDGP participation status and source of emissions savings (either from change in population or change in emissions efficiency due to improvements in genetic merit). This illustrates the different sources of change in emissions over the period, with 457 KT CO^2eq saved from a reduction in cow numbers as well as a further 34 KT CO^2eq saved due to improvements in genetic merit, generating an overall annual saving of 491 KT CO^2eq from the national suckler cow herd in 2021 compared to 2015. This is equivalent to saving c. 13.6% of 2015 GHG output. This represents a cumulative saving of 1.32 MT CO^2eq within 2016-2021 compared to emissions remaining at their 2015 level, with permanent savings continuing to build over time. It's also important to note that these improvements will ensure that there remains future potential to improve the emission profile from the future beef sector.

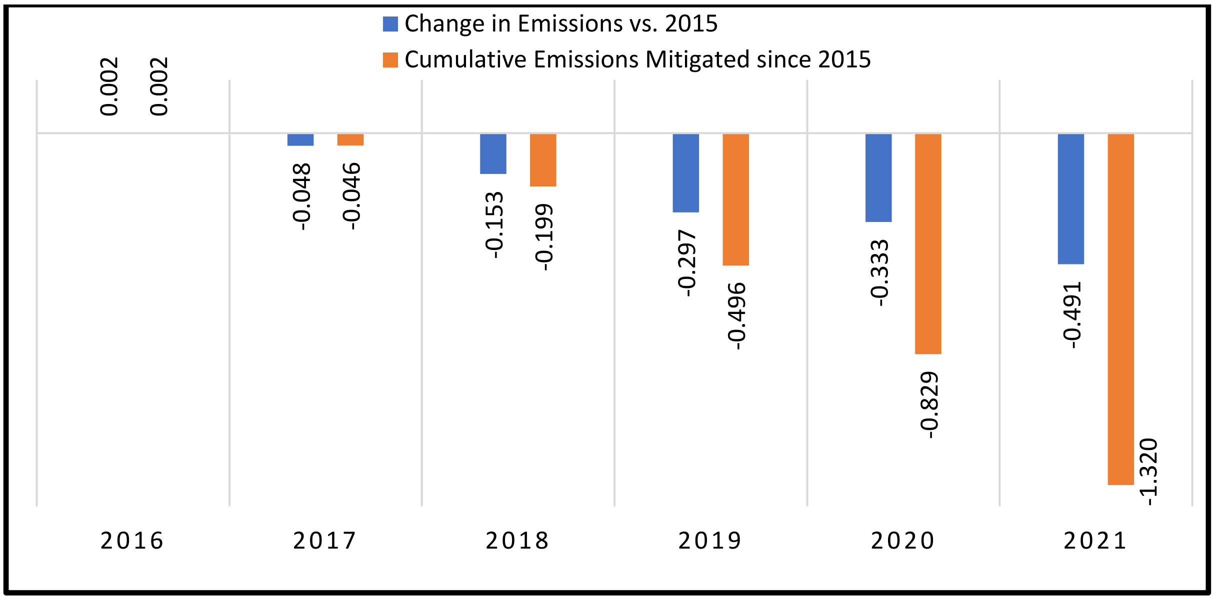


Figure Fifteen: Individual Year and Cumulative GHG difference in emissions compared to 2015 (MT CO2e) for suckler beef overall. Source: Author's Calculations based on ICBF data.

When we isolate savings due to genetic improvement alone, BDGP herds are the dominant source, with the spill-over effects contributing to the non-BDGP savings. As genetic improvements are permanent and cumulative, these savings will build over time and make an increasing contribution to emissions savings overall.

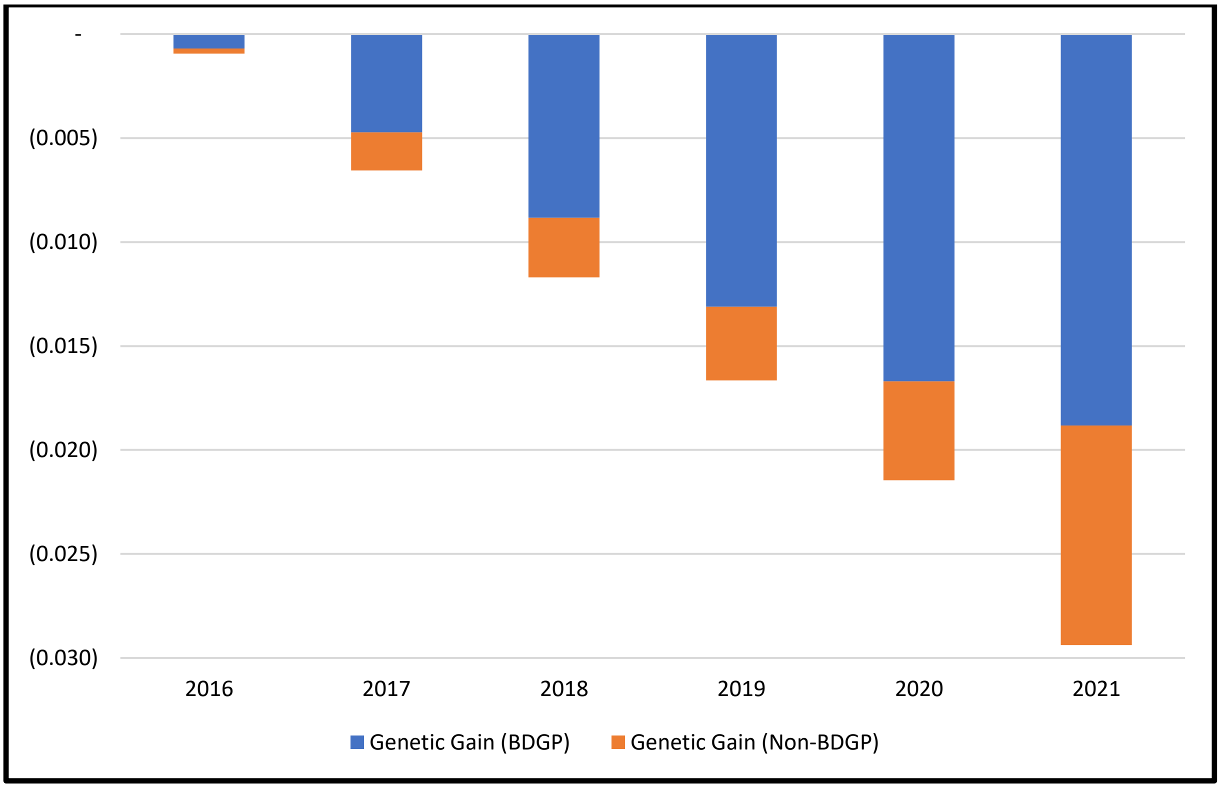


Figure Sixteen: Difference in Emissions per Year compared to 2015 (MT CO2e) due to Genetic Improvements to date 2015-2021. Source: ICBF.

ICBF Projections for Overall Beef Sector at 2030

If the current trends in genetic merit continue as projected, the ICBF estimate the following could evolve for the overall beef sector (for BDGP and non-BDGP herds):

- production could increase by 6.1 KG of meat per cow per year at 2030 compared to 2021, or an average gain of 0.61 KG per annum over the period, to 182 KG;
- gross emissions could decrease by c. 7.5 kg CO2e per cow per year on average, with CO2e per cow falling to 3.401 T CO^2eq p.a. compared to a baseline 3.476 Tonnes; and
- emissions intensity could improve by 0.1 kg CO^2e per cow per year on average over the period, to 18.69 KG CO^2eq per KG beef produced at 2030.

Taken together this represents a **67.8 kt decrease in emissions (-2.1%).** It is important to note that this 2% decrease is based on maintaining the current population of animals of c. 908,000. To maintain the same level of output, the herd could fall to c. 878,000 due to the 'locked-in' genetic gains meaning emissions per cow will fall to 3.4 T CO2eq per annum. This would represent a **171.3 KT CO^2e decrease (-5.4%)** in emissions at a population level while producing the same quantity of beef as in 2020, or an additional **103.6 KT CO2eq (3.3%)** saved compared to the fixed population scenario.

Indicator / Scenario	2021 Baseline	2030 Fixed Population	2030 Fixed Output
Production Output (KT Beef)	159.7	165.2	159.7
Emissions Intensity (KG CO2eq per KG Beef)	19.76	18.69	18.69
Gross Emissions (KT CO2eq)	3,156	3,088	2,984
Percentage (%) Difference in Gross Emissions vs. 2021	-	-2.1	-5.4

Table Ten: Summary of Outcomes in Emissions Intensity and Gross Emissions at 2030 based on ICBF projections of improvements in genetic merit, for a given level of output or fixed population of cows. Source: ICBF. Gross Emissions at 2021 based on a population of 908,000 cows generating 3.476 T CO2eq per year.

Further declines in population would lead to larger savings in emissions, but these would have to be balanced against the socio-economic value generated by the sector, and the emissions profile of the replacement activity on the land. It is also important to reiterate that while decreasing populations does lower emissions, it also lowers the scale of further opportunities for mitigation, as there are less units from which to improve on.

Similarly, once other mitigation opportunities such as measures within the Beef Environmental Efficiency Programme (BEEP), dairy-beef sector developments and calf DNA, these savings could increase to up to 11.4% mitigation by 2030. This would build on the fixed output scenario reduction of 5.4%. These measures would simultaneously generate significant economic gain, quantified at €606m in market value based on the maternal gains, or an average of €48m per year to 2030. This can ensure that the future performance of the herd can produce lower overall emissions due to the measures implemented now under schemes such as the BDGP.

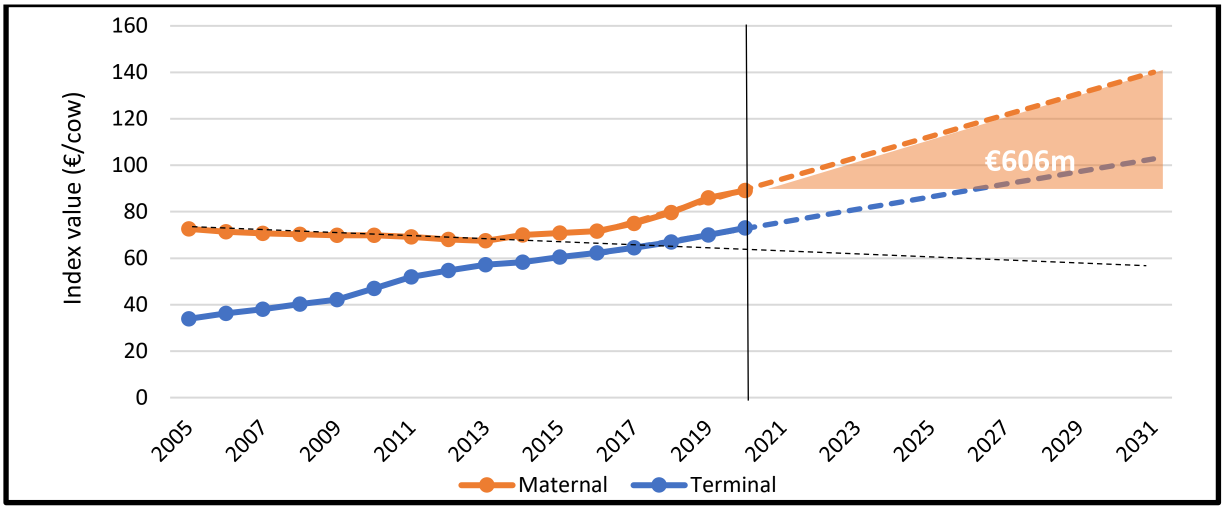


Figure Seventeen: Value of Replacement and Terminal Indices 2005-2030 (2022-2030 Predicted) based on Current Genetic Trends. Source: ICBF. Note: Dotted black line is counterfactual Rep. Index value based on linear pre-BDGP trend. The area under the dotted red line represents market value of future maternal benefits, valued at €606m per year at 2030. Further value of €355m will also be accrued at 2030, giving a total market value of €961m at 2030 compared to the base year.

The figure below illustrates how emissions intensity could reduce per cow.

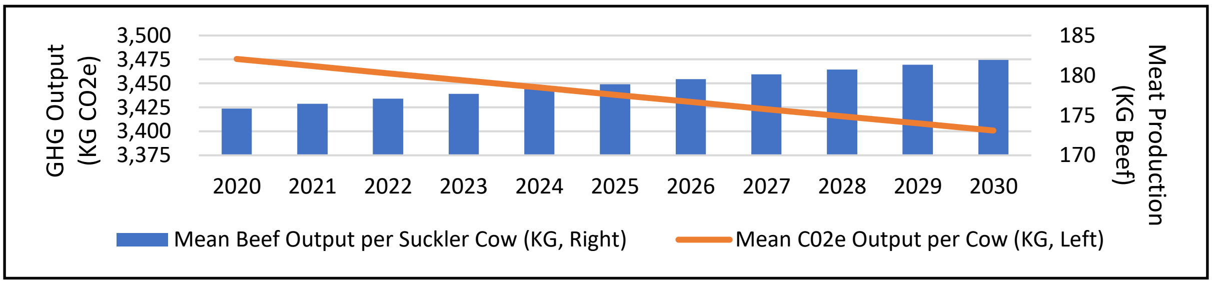


Figure Eighteen: Mean Emissions and Beef Output per Suckler Cow 2020-2030 at current genetic trends. *Source: ICBF.*

Additional opportunities to accelerate reductions in emissions could also be considered to generate further progress, including:

(i) Further genotyping,
(ii) Direct selection on methane traits in the relevant indices (as opposed to relying on predictor traits such as cow size etc.) and
(iii) Recalibrating the traits within the indices to place more emphasis on the climate/environmental traits in future indices:
(iv) Promoting an earlier finishing age.

Combined with the current trends, these additional initiatives have the potential to reduce CO2e via breeding measures by up to 8.9%, with these gains primarily from having smaller, more fertile cows, thereby reducing the costs of keeping replacements etc. Placing a cap on output while reducing the population of cows moderately (to c. 800,000 head) would result in a further net reduction in GHG output of c. 3.9% – through the option to keep less cows for the same level of output – meaning gross emissions could be as much as 13.8% lower at 2030 compared to 2021.

Emissions Impact of BDGP to 2030 and 2035 at Current Trends

Isolating the potential impact of BDGP in terms of increases in genetic merit, if current trends continue and assuming a fixed population of approx. 490,000 cows as at 2021, emissions from cows in BDGP could be 96 KG CO^2eq lower per cow per annum compared to 2015 at 2030. This translates to a saving of 47 KT CO^2eq per annum compared to 2015 from genetic gains on the maternal side, as measured by the Replacement Index. These same figures could reach 128 KG CO^2eq per cow at 2035 and an overall saving of 63 KT CO^2eq per annum from the BDGP herd at a constant 2021 population level.

BDGP Emissions Savings vs. 2015	Per Cow per Year	Total Per Year (Fixed Population)	Cumulatively Since 2015 (Fixed Population)
Unit	*KG CO2e*	*KT CO2e*	*KT CO2e*
At 2030	96	47	372
At 2035	128	63	654

This does not take into account the cumulative and permanent spill-over effects for non-BDGP herds. These estimates are based on a continuation of the 2016-2021 average year-on-year gain in Replacement Index of €3.95 per cow, with a saving of 0.81 KG CO^2eq for every €1 increase in the value of the index, as per Quinton et al (2018). Over the period 2016-30, this represents a 373 KT CO^2eq saving cumulatively, rising to 656 KT CO^2eq for the period 2016-35. This efficiency saving will be lower if cow numbers reduce from their 2021 level over the period, as less mitigation is possible from a smaller population. The charts on the following page illustrate these projections over the medium-to-long term.

Among non-BDGP herds, due to spill-over benefits from BDGP, the savings estimated by this method (from approx. 420,000 cows and a assuming a continuation of the average year-on-year rate of gain in the Replacement Index of €2.20 per cow) would be 54 KG CO2e per cow per annum at 2030 compared to 2015; an aggregate non-BDGP population saving of 22.6 KT CO^2eq per annum at 2030 compared to 2015, and 30 KT CO^2eq per annum at 2035; and a cumulative saving of 172 KT CO^2eq over the period 2016-30, rising to 307 KT CO^2eq over 2016-2035. Overall, adding BDGP and non-BDGP savings together, the sector can save the following levels of emissions at 2030 and 2035 from greater efficiency from a fixed (2021) population:

Total (BDGP and Non-BDGP) Emissions Savings vs. 2015	Per Cow per Year	Total Per Year (Fixed Population)	Cumulatively Since 2015 (Fixed Population)
Unit	*KG CO2e*	*KT CO2e*	*KT CO2e*
At 2030	77	70	544
At 2035	102	93	961

This is the effect of genetic gains due to BDGP (including spill-over effects for non-BDGP herds) when compared to a scenario of a stagnant 2015 Replacement Index mean value. This also assumes a constant population at its 2021 level of c. 908,500 cows out to 2030/35.

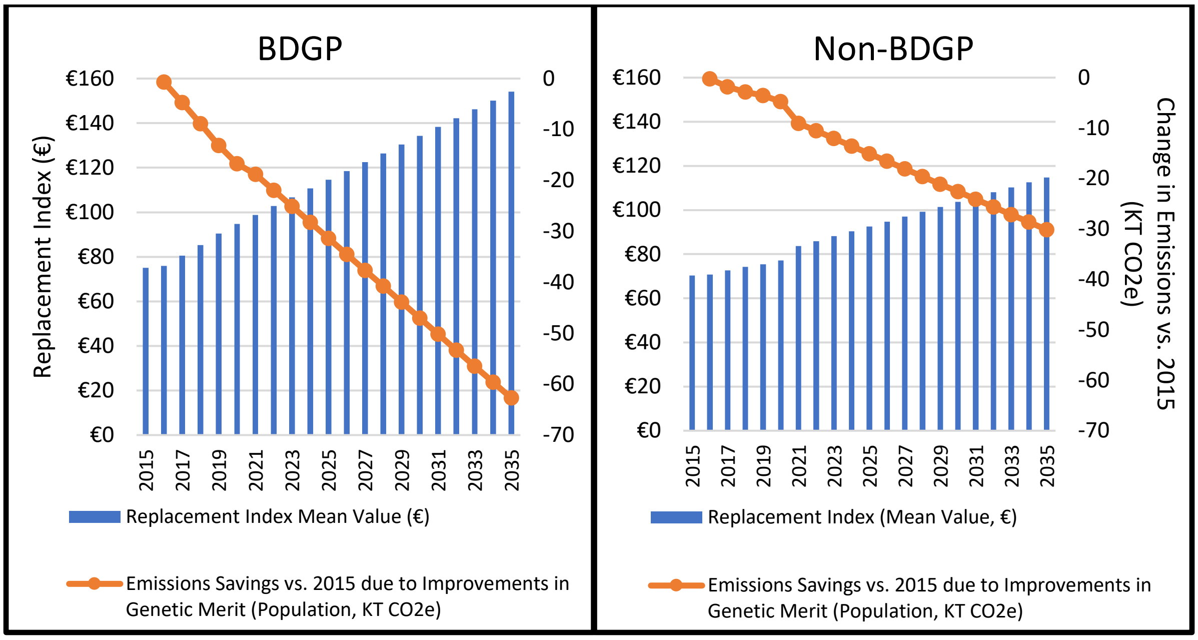


Figure Nineteen: Replacement Index mean value, and Change in Emissions compared to 2015 per Year, if Current Trends Continue among BDGP and non-BDGP cohorts. Source: Author's Calculations based on ICBF data.

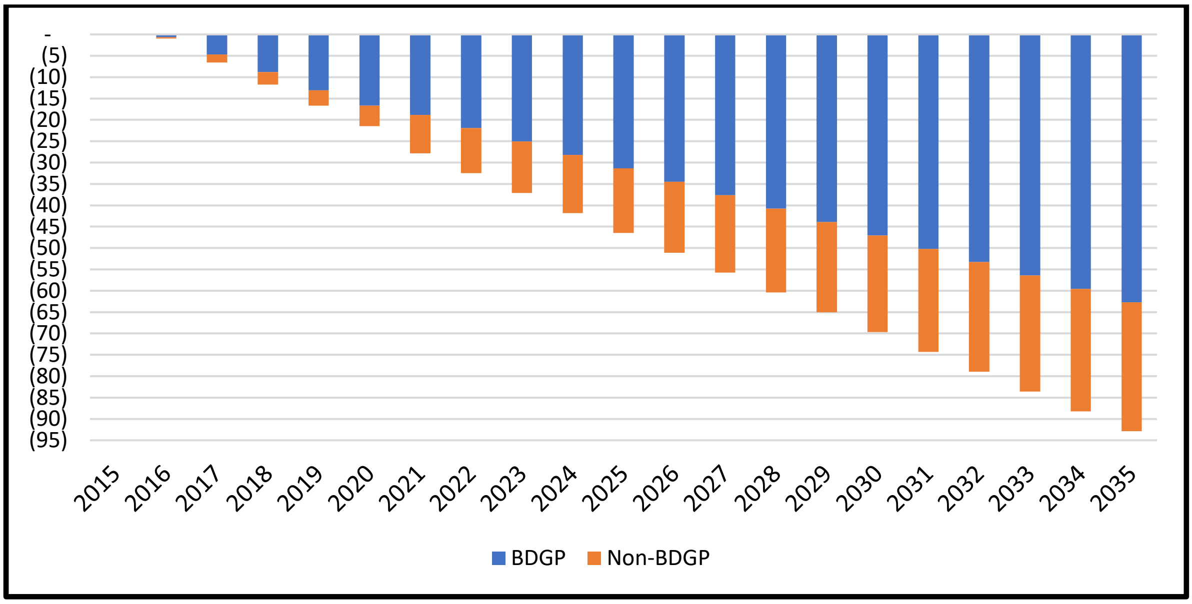


Figure Twenty: Overall Change in Emissions vs. 2015, due to Improvements in Maternal Traits of Genetic Merit, among BDGP and non-BDGP herds by BDGP participation status. Source: Author's Calculations based on ICBF data.

Sensitivity Analysis of BDGP Emissions Impact

The below presents a sensitivity analysis for these projections based on variation in the assumed rate of change in the number of cows enrolled in BDGP and the year-on-year change in the mean value of the Replacement Index among the BDGP population. Terminal traits are not considered in these scenarios. This analysis illustrates that a greater population and rate of genetic gain represent the greatest level of opportunity for mitigation from genetic merit gains. Scenario A corresponds to the projections discussed above and represents the central Business-as-Usual scenario. The scenarios and their range of estimates are presented below.

Scenario	Description	Cow Population			Replacement Index (Mean, €)		
		2021	2030	2035	2021	2030	2035
A	Cow Numbers constant at 2021 Level to 2035; Replacement Index Increases Year-on-Year at its 2016-21 Average Rate.	488,625	488,625	488,625	99	134	154
B	Cow Numbers Reduce at 2016-21 Average Rate; Replacement Index Increases Year-on-Year at its 2016-21 Average Rate.	488,625	449,724	428,112	99	134	154
C	Cow Numbers constant at 2021 Level; Replacement Index Increases Year-on-Year at double its 2016-21 Average Rate.	488,625	488,625	488,625	99	170	209
D	Cow Numbers reduce at 2016-21 Average Year-on-Year Rate; Replacement Index Increases Year-on-Year at double its 2016-21 Average Rate.	488,625	449,724	428,112	99	170	209
E	Cow Numbers constant at 2021 Level; Replacement Index Increases Year-on-Year at half its 2016-21 Average Rate.	488,625	488,625	488,625	99	117	126
F	Cow Numbers reduce at 2016-21 Average Year-on-Year Rate; Replacement Index Increases Year-on-Year at half its 2016-21 Average Rate.	488,625	449,724	428,112	99	117	126
G	Cow Numbers constant at 2021 Level; Replacement Index continues at its 2009-2013 average rate of change year-on-year (i.e. no BDGP).	488,625	488,625	488,625	72	67	64
H	Cow Numbers reduce at 2016-21 Average Year-on-Year Rate; Replacement Index continues at its 2009-2013 average rate of change year-on-year (i.e. no BDGP)	488,625	449,724	428,112	72	67	64

Scenario	Emissions Saved per Cow vs. 2015 (KG CO^2e)			Emissions Saved per Year vs. 2015 (KT CO^2e)			Emissions Saved Cumulatively since 2015 (KT CO^2e)		
	2021	2030	2035	2021	2030	2035	2021	2030	2035
A	38	96	128	19	47	63	63	372	654
B	38	96	128	19	43	55	63	357	608
C	38	154	218	19	75	106	63	513	982
D	38	154	218	19	69	93	63	490	908
E	38	67	83	19	33	41	63	302	490
F	38	67	83	19	30	36	63	291	458
G	-6	-14	-19	-3	-7	-9	-10	-55	-96
H	-6	-14	-19	-3	-6	-8	-10	-53	-89

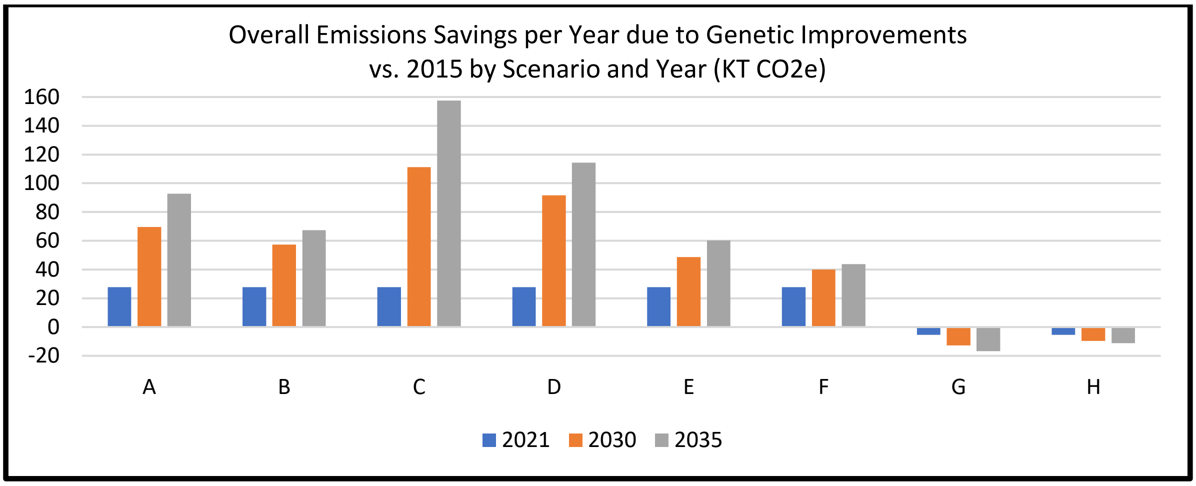
Scenario	Shadow Emissions Cost Savings per Year vs. 2015 (Discounted, € 000)[22]			Cumulative Shadow Emissions Cost Savings since 2015 (Discounted, € 000)		
	2021	2030	2035	2021	2030	2035
A	732	3,427	4,807	1,811	21,335	42,551
B	732	3,154	4,212	1,811	20,310	39,249
C	732	5,483	8,173	1,811	30,558	65,926
D	732	5,047	7,161	1,811	28,996	60,562
E	732	2,399	3,125	1,811	16,724	30,864
F	732	2,208	2,738	1,811	15,966	28,592
G	-106	-498	-699	-283	-3,120	-6,203
H	-106	-458	-612	-283	-2,971	-5,723

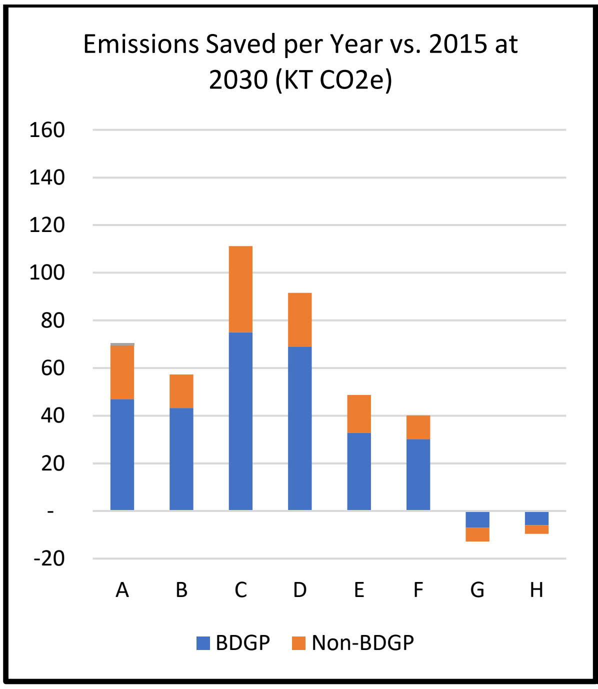
The tables below present the estimates when non-BDGP herds are also included under the equivalent scenarios. This highlights the increasing share of emissions savings due to genetic merit improvements in shaping future mitigation potential:

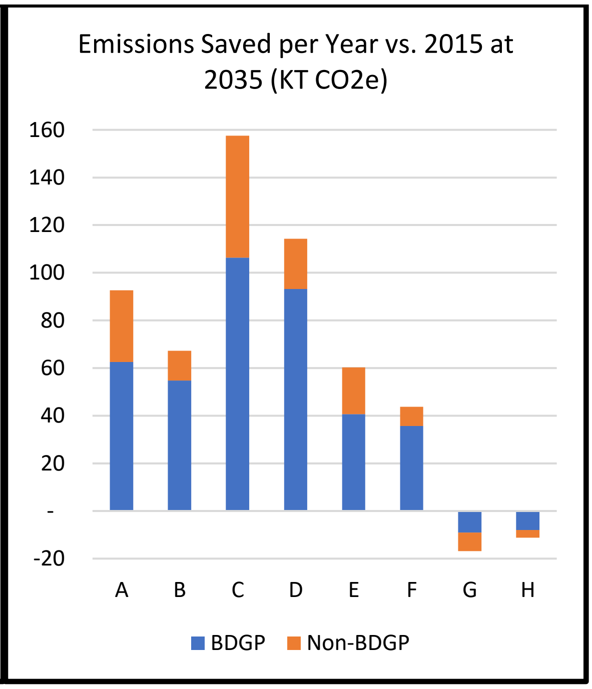
Scenario	Cow Population			Emissions Saved per Year vs. 2015 (KT CO2e)			Emissions Saved Cumulatively since 2015 (KT CO2e)		
	2021	2030	2035	2021	2030	2035	2021	2030	2035
A	908,477	908,477	908,477	28	70	93	85	544	961
B	908,477	711,250	601,679	28	57	67	85	493	811
C	908,477	908,477	908,477	28	111	158	85	752	1,448
D	908,477	711,250	601,679	28	92	114	85	676	1,206
E	908,477	908,477	908,477	28	49	60	85	440	718
F	908,477	711,250	601,679	28	40	44	85	402	614
G	908,477	908,477	908,477	-5	-13	-17	-19	-102	-178
H	908,477	711,250	601,679	-5	-10	-11	-19	-91	-145

[22] The Shadow Cost of Carbon estimates the likely economic costs of removing GHGs generated by carbon-equivalent emissions in terms of their Global Warming Potential (GWP). Methane, for example, is equivalent to 25 Tonnes of Carbon under International Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) criteria. The Shadow Price of Carbon is valued in the 2019 DPER Public Spending Code (PSC) at €46 per tonne of CO2e for non-ETS sectors in 2022, rising to €100 at 2030. Shadow costs have been discounted at 4% per year for 2022-2035 in the estimates presented here, as per the PSC *Central Technical References and Economic Appraisal Parameters*. Emissions within 2015-2019 were valued at €20, and those within 2015-2021 were not discounted.

Scenario	Shadow Emissions Cost Savings per Year vs. 2015 (Discounted, € 000)			Cumulative Shadow Emissions Cost Savings since 2015 (Discounted, € 000)		
	2021	2030	2035	2021	2030	2035
A	1,084	5,080	7,126	2,485	31,423	62,870
B	1,084	4,184	5,170	2,485	28,056	52,025
C	1,084	8,127	12,113	2,485	45,093	97,516
D	1,084	6,694	8,790	2,485	39,966	79,901
E	1,084	3,556	4,632	2,485	24,588	45,546
F	1,084	2,928	3,361	2,485	22,101	38,087
G	-197	-926	-1,299	-525	-5,799	-11,531
H	-197	-725	-860	-525	-5,044	-9,098







Figures Twenty-One to Twenty-Three: Emissions saved per Year at 2030 and 2035 by cohort and scenario. *Source: Author's Calculations based on ICBF data and Quinton et al (2018) estimates of emissions savings from replacement index gains.*

Conclusion

The BDGP has made a significant impact for the Irish beef sector in setting a pathway to a more sustainable future, by encouraging the necessary actions to be taken now to ensure the required structures are in place to produce a more economically efficient and lower emitting beef product in the future. While the methodology employed focuses on aggregated rather than individual farm level impacts, the evidence generated by the scheme to date indicate positive trends which will be cumulative and permanent, thus making a significant impact over time.

The genetic gain achieved to date has surpassed original expectations and the KPI's are progressing as intended. BDGP participants are achieving improvements at a faster rate than their non-BDGP counterparts, who also benefit from a positive spill-over of the scheme. As the national herd continues to move towards higher genetically rated animals becoming the norm, the impact of the BDGP can promote smaller, more efficient, more fertile and milkier suckler cows, which can produce a more efficient beef output – i.e. from a lower level of input – with direct benefits for GHG emissions.

However, there are still further opportunities to accelerate this progress to meet the climate objectives for the sector and a list of recommendations is provided below.

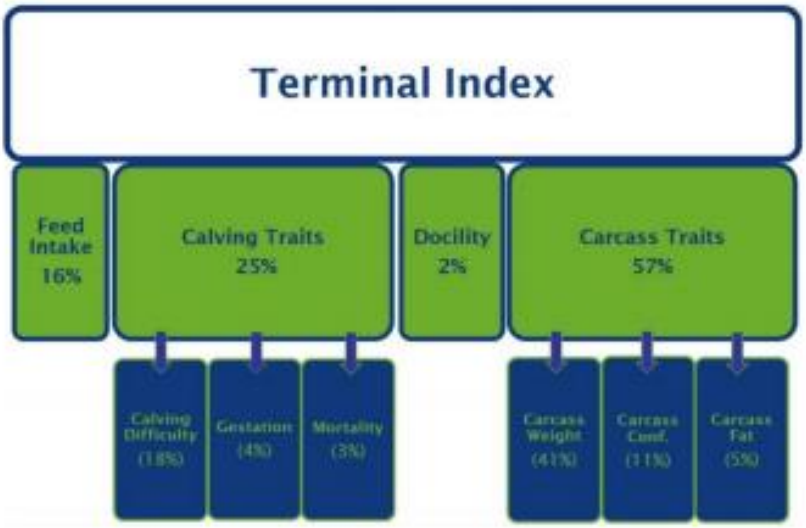
Recommendations

- A new iteration of BDGP is needed to ensure continued improvements, with a strong emphasis on a data-driven scheme which incorporates areas such as the highest possible level of genotyping, increased use of 4/5 star animals, and recording of more data on farms.
- Merge the data collected under BDGP with performance related data such as that collected under BEEP-S to ensure a holistic approach to improving sector sustainability. This will help improve whole-of-life performance, leading to greater efficiencies which can provide economic and environmental benefits.
- Leverage Knowledge Transfer activities to improve and increase the impact of the Carbon Navigator and other tools at farm level.
- Continued research on environmental traits within the €urostar Index, such as through direct selection for methane traits to identify potential methods to further develop environmental performance improvements. Similarly, further analyses into areas such as younger finishing age, informed by the data could help accelerate gains.
- Continue to drive progress to achieve heightened level of ambition on genetic gain to meet dual objectives of economic and environmental efficiency improvements, including for new entrants to meet scheme requirements.

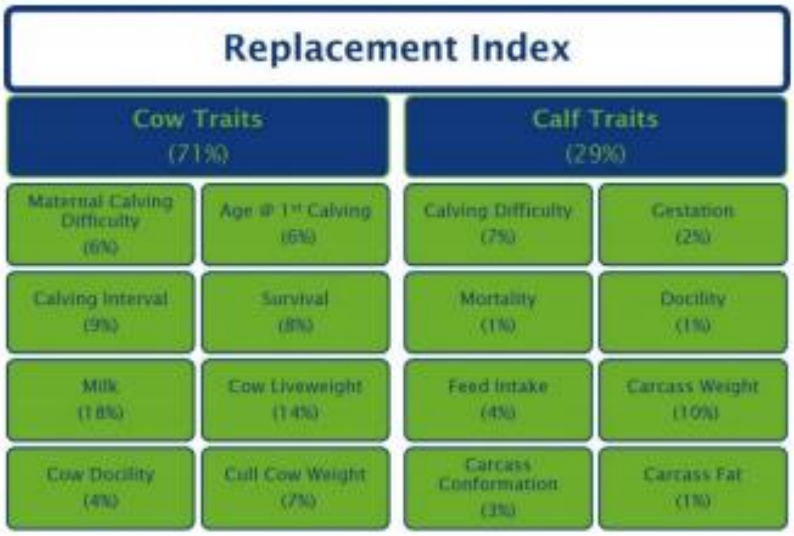
Appendix One: Understanding the €uro-Star (Replacement & Terminal) Index.

The €urostar Index is a profit focused index designed for Ireland's beef sector. The €urostar Index is divided into the Terminal and Replacement indexes, with traits grouped together according to their importance to achieving the overall goal.

The principle of the Terminal Index is based on low costs of production, *i.e.* low cost associated with calving, low mortality, short gestation, less feed consumed per kilogram of carcass and as high a return on the carcass as possible. In short, the Terminal Index estimates how profitable an animal's progeny will be with regards to live weight, carcass conformation and being finished for slaughter.



The Replacement Index estimates how suitable an animal's daughters will be for calving ability, milk, fertility, and ultimately being low maintenance suckler cows. Cow Contribution accounts for the performance of direct daughters for Milk, Calving Interval, Cull Cow Weight, etc. Calf Contribution reflects the performance of the progeny of daughters for traits such as Feed Intake, Carcass Weight, Carcass Conformation, etc.

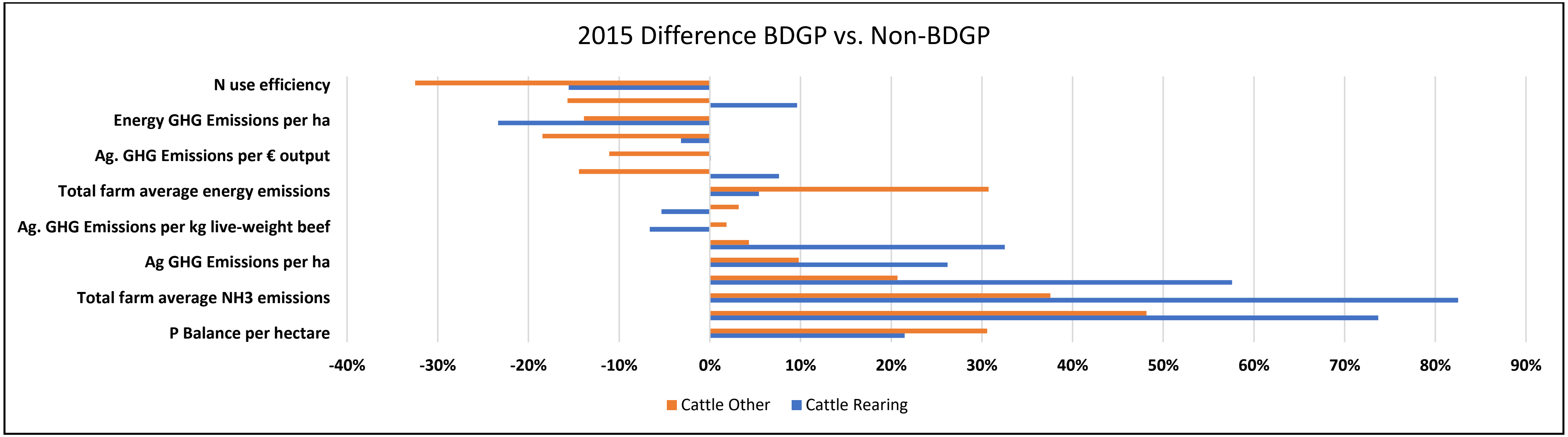


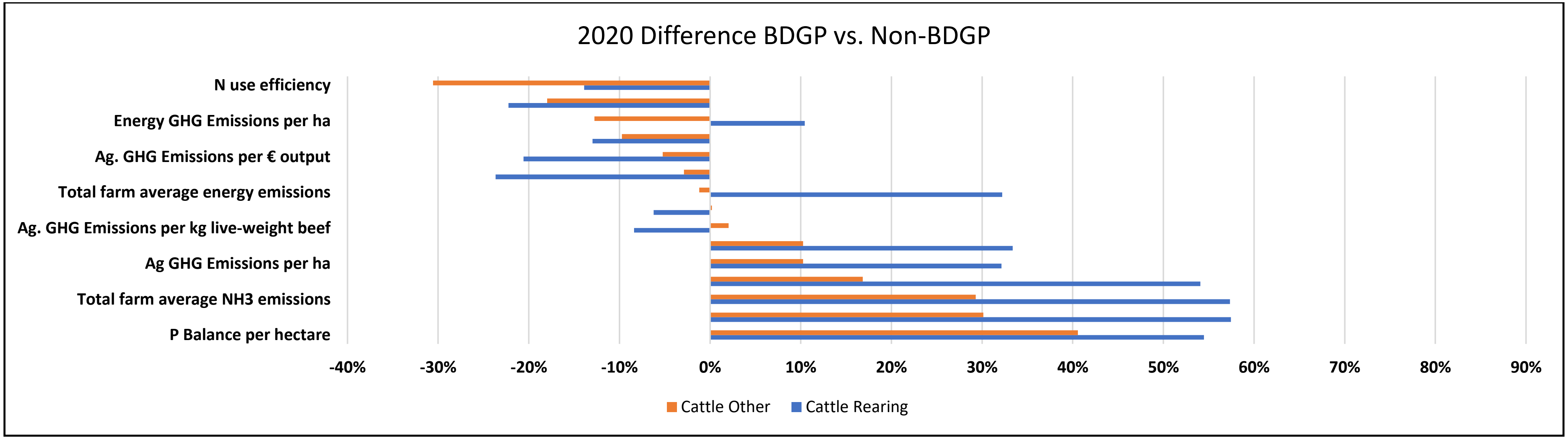
The table below shows the composition of the Replacement Index.

Trait	Economic Weight (€)	Trait Emphasis (% Weight)	Trait Type (Weight)
Maternal Calving Difficulty	-4.98	6	*Cow Traits (71%)*
Age at First Calving	-0.99	6	
Calving Interval	-5.07	9	
Survival	8.86	8	
Milk	5.58	18	
Heifer Intake	-0.76	8	
Cow Intake	-0.55	6	
Cow Docility	77.27	4	
Cull Cow Weight	0.91	7	
Calving Difficulty	-5.12	7	*Calf traits (29%)*
Gestation	-2.48	2	
Mortality	-5.87	1	
Docility	14.72	1	
Feed Intake	-0.07	4	
Carcass Weight	2.1	10	
Carcass Conformation	10.22	3	
Carcass Fat	-5.44	1	

Source: ICBF.

Appendix Two: Difference in environmental outcomes between BDGP and Non-BDGP herds in 2015 and 2020. Source: Author's Calculations based on Teagasc NFS Data.





Quality Assurance process

To ensure accuracy and methodological rigour, the author engaged in the following quality assurance process.

- ⊗ Internal/Departmental
  - ⊗ Line management
  - ⊗ Spending Review Steering group
  - ⊗ Other divisions/sections
  - ☐ Peer review (IGEES network, seminars, conferences etc.)

- ⊗ External
  - ☐ Other Government Department
  - ☐ Other Steering group
  - ☐ Quality Assurance Group (QAG)
  - ☐ Peer review (IGEES network, seminars, conferences etc.)
  - ⊗ External expert(s)

- ☐ Other (relevant details)

An Roinn Caiteachais
Phoiblí agus Athchóirithe
Department of Public
Expenditure and Reform

Tithe an Rialtas. Sráid Mhuirfean Uacht,
Baile Átha Cliath 2, D02 R583, Éire
Government Buildings, Upper Merrion Street,
Dublin 2, D02 R583, Ireland

T:+353 1 676 7571
@IRLDeptPer
www.per.gov.ie