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Beef Environmental Efficiency Programme – Sucklers (BEEP-S)

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Executive Summary

The Irish beef sector produced 633,000 tonnes or €2.29bn of output in 2020 (c. 26% of total goods output value from the primary agriculture sector) and represented 16% (€2.33bn) of total agri-food export value. The sector also, however, faces challenges in terms of economic viability, with cattle rearing farms consistently recording the lowest average Family Farm Income (FFI) in successive Teagasc National Farm Survey (NFS) reports. This is largely due to such farms being relatively smaller in terms of scale. Beef farming also faces environmental challenges in terms of the level of national agricultural GHG emissions[1]. The number of non-dairy cows in Ireland has fallen c. 23% from the most recent high-point of 1.22m in June 2008, to 0.940m in June 2021, and is likely to fall further by 2030[2]. Teagasc NFS Sustainability Report data suggests that the emissions efficiency of cattle farming – as measured by kilograms of CO2eq per kilogram of beef produced – has improved by 4% between 2015-2019[3]. Further improvement, including convergence between top- and bottom-performing farms, is required to ensure the objective of emissions intensity progress is realised overall and that this translates to absolute emissions savings at the national level.

The Beef Environmental Efficiency Programme – Sucklers (BEEP-S) contributes to this objective, while supporting improved economic outcomes, by encouraging the use of animal health and performance data to inform on-farm decision making. Participants were paid to weigh suckler cow/calf pairs, as well as to complete optional actions including meal feeding, vaccination, and faecal egg testing. This promotes best practices in animal and herd management.

Producing a more efficient suckler cow herd will bolster economic performance and reduce GHG emissions intensity due to improved animal health and performance, particularly in the medium-to-long term as cumulative gains are realised. Supporting evidence-based farm-level breeding decisions will aid absolute emissions reductions as farmers utilise timely and relevant data to replace stock with more efficient animals; these, in turn, have lower feed requirements and higher output value, enabling slaughter at a younger age. More efficient cattle have a higher Average Daily Gain (ADG) in live-weight for a given level of feed input, and are more resilient to disease; this improved productivity and lower mortality leads to unit efficiency improvements. As the overall herd becomes more efficient over time, assuming stable total animal numbers, improvements can help to reduce the aggregate level of sector emissions. Participants benefit from more efficient animals and compensation of labour & input costs, while the State and wider society benefit from the economic contribution of the sector and reduced emissions levels.

25,880 farmers received payments totalling c. €41.08 million for participating in the BEEP-S scheme in 2020, giving a mean payment of €1,587 per successful applicant. Almost 98% of c. 27,300 BEEP-S applicants opted for meal-feeding (85.7%) or vaccination (12.2%) as part of

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[1] Author's calculations based on Buckley, C. and Donnellan, T. (2020) *NFS Sustainability Report 2019*.
[2] Buckley, C. and Krol, D. (2020) *An Analysis of the Cost of the Abatement of Ammonia Emissions in Irish Agriculture to 2030*. Teagasc.
[3] Author's Calculations based on *Teagasc NFS Sustainability Report 2019*, p.71 (Appendix One, Table 6).

Optional Action A, in support of lowering the incidence of pneumonia. 73.5% of applicants opted for faecal egg testing under Optional Action B. There was a 95% likelihood of an application being successful overall. 92.6% of successful applicants were paid for completing at least one optional additional measure, while 64% of participants were paid for completing weighing and both optional actions A and B.

BEEP-S is one aspect of a wider policy approach for the beef sector and is complementary to the Beef Data Genomics Programme (BDGP), with c. 85%) of BEEP-S participants also enrolled in BDGP. BEEP-S farmers tended to be younger, farmed larger areas, hold higher numbers of stock and earn higher incomes on average than those who did not participate in BEEP-S.

Key Findings

BEEP-S – based on an additional 15% selection accuracy due to access to data on weights and animal performance, or 8.25% when weighted – can be expected to generate 14.9 KT CO2e emissions mitigation at 2030. This is equivalent to c. 0.5% of 2020 baseline emissions. This translates to a permanent economic value of c. €51.5m at 2030, based on a stable herd. This includes market value of genetic improvements and shadow emission cost savings generated by efficiency improvements. Additional gains will also arise from improvements due to BEEP-S, such as through improved technical efficiency and improved animal welfare outcomes.

Although a longer reference period is required to fully evaluate the cumulative efficiency improvements which can accrue over time, the current evidence suggests positive economic and environmental outcomes from BEEP-S, particularly when considered in conjunction with schemes such as BDGP. Below, the efficiency gap between low- and high-rated cows (in terms of genetic merit) is illustrated using ICBF BEEP-S herds data.

Indicator	Cow Star Rating							Efficiency Gap
Metric	One	Two	Midpoint (One/Two Star)	Three	Four	Five	Midpoint (Four/Five Star)	Difference 5* vs 1*
Weaning Efficiency (%)	34	41	37.5	45	50	61	55.5	+27
200-Day Calf Average Daily Live-weight Gain (kg)	1.01	1.19	1.1	1.28	1.38	1.57	1.48	+0.56
Dam Replacement Index Value (€)	81	90	85.5	93	97	102	99.5	+21
Age of Calf at Slaughter (Days)	731	694	712.5	669	642	597	619.5	-134

Promoting high-merit cows can therefore translate to economic and environmental savings over time as four- and five-star cows become predominant in the national herd:

- High genetic merit animals are currently slaughtering at 20 kilograms heavier and 7 days younger, equivalent to approx. one month if slaughtered at the same carcass weight.
- Each one-month reduction in age of slaughter of prime animals from the suckler herd abates c. 115 KT of GHG CO2eq (c. 7.3% of total emissions), assuming no change in the herd size. This is equivalent to not replacing c. 21,000 suckler cows.

If current genetic trends continue, the ICBF project that aggregate beef sector GHG emissions output will be 2.1% lower than the current (2020) level for a constant number of cows, or 5.4% lower for a given level of beef produced, by 2030. This translates to 18.9kg less CO2e emitted per 175kg beef produced per suckler cow. This includes gains from BDGP.

Further, the review also identified some recommendations:

- Continue to build the National Herd Dataset further and integrate this evidence base with other sustainability metrics – particularly in the areas of climate, animal health and welfare. This can, if such collated information is disseminated effectively, inform farm-level decisions and improve aggregate environmental and economic outcomes.
- Incorporate the principles of BEEP-S alongside BDGP in an integrated approach, as both are complementary in improving the national beef herd through permanent cumulative gains. Performance data such as weights and weaning efficiency estimates can be used in conjunction with genetic information by farmers to inform production decisions.
- Improve the communication of the benefits of the vaccination option to ensure a greater level of uptake, and likewise to improve the compliance rate for faecal egg testing.
- Build on the evidence base established to date by incorporating silage quality metrics, and/or the use of optimum level of crude protein content in meal feed, to enhance these performance-based metrics further.

Glossary of Terms

AIM	Animal Identification and Movement system, operated by DAFM to trace animal movements.
BEEP	Beef Environmental Efficiency Pilot
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.
CO2e	Carbon Dioxide Equivalents; unit of measurement for Greenhouse Gas emissions adopted by the IPCC
CO	Cattle Other
CR	Cattle Rearing
DAFM	Department of Agriculture, Food and the Marine
DPER	Department of Public Expenditure and Reform
ETS	Emissions Trading System of the European Union.
€uro Star Replacement Index (RI)	A beef breeding index rated as 1-5 stars, with five star cows being the most efficient based on animal traits.
GHG	Greenhouse Gas Emissions
Heifer	A female bovine that has not previously calved.
ICBF	Irish Cattle Breeding Federation
IPCC	International Panel on Climate Change
MACC	Marginal Abatement Cost Curve; illustrates GHG mitigation options in terms of cost per tonne abated.
NCAP	National Climate Action Plan
NFS	Teagasc National Farm Survey
NHD	National Herd Dataset
Suckler Cow	A beef breed cow which produces/rears a calf for meat production and not to supply milk commercially.

1. Introduction

The Irish beef sector is a structurally important indigenous industry, producing 633,000 tonnes or €2.3bn in output and representing 16% of total agri-food export value in 2020[4]. The sector has also been recognised in the Food Vision 2030 strategy as a principal driver of expanding Irish agri-food exports. 58.7% of all 78,300 classified by the CSO as specialist beef farms, i.e. those where beef is the predominant output, are located in the Border-Midlands-West (BMW) region. These farms represent 63% of all family farms in the BMW region[5], where overall agri-food represents approximately one in eight jobs compared to one in twelve nationally[6]. Beef output and processing have output multiplier coefficients of approx. 2.5 and 1.9, 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[7]. Grass-based beef systems, prevalent in Irish farming, also provide ecosystem services and can utilise land unsuitable for crops[8].

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. Environmental Protection Agency (EPA) estimates for 2019 show agriculture contributed 35.3% of overall Irish GHG carbon-equivalent emissions, or 46.2% of national non-ETS (European Trading System) emissions. This reflects the emissions intensity of ruminant livestock, the relatively large size of the agriculture sector in Ireland, and the relative lack of national industrial development. As part of the National Climate Action Plan 2019, the agriculture sector must reduce its emissions to between c. 17.5-19 Million Tonnes (MT) of Carbon Dioxide Equivalent (CO2e) by 2030, or a 10-15% reduction on the 2018 baseline[9]. The *Ag-Climatise* roadmap to achieve these sectoral ambitions outlines that it *"is based on stabilising methane emissions and a significant reduction in fertiliser-related nitrous oxide emissions"*[10]. Further, the Climate Action and Low Carbon Development (Amendment) Bill 2021 has signalled increased climate ambition. Discussions around sectoral carbon budgets and other issues are ongoing, however.

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[4] CSO (2021) Agricultural Output, Input and Income; Livestock Slaughterings. Tabes AEA01 and ADM01.
[5] CSO (2018) *Farm Structure Survey 2016*, Table 2.2.
[6] Conefrey, T. (2018) *Irish Agriculture: Economic Impact and Current Challenges* in Central Bank of Ireland Economic Letters, Vol. 18, Issue 8, p.11.
[7] 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*
[8] 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*"
[9] EPA (2020) *National Inventory Report 2020 (1990-2018)*, p.151, Table 5.2.
[10] DAFM (2020) *Ag-Climatise: National Climate and Air Roadmap for the Agriculture Sector*, p.9.

Specialist Beef (Cattle Rearing and Cattle Other) farms represented in the *National Farm Survey (NFS)* contributed approx. 7.3 MT agricultural CO2e in 2019; this estimate increases to 11.59 MT CO2e when emissions from cattle enterprise on farms in other specialist systems (dairy, sheep and tillage) are included. This translates to c. 40% or 64% of emissions from farms represented in the NFS, respectively, as seen in Table One[11]:

System	Number of Farms Represented in NFS (000s)	UAA per Farm (Ha.)	Aggregate System UAA (000 Ha.)	Average Farm Emissions (T CO2e)	Aggregate System Emissions (MT CO2e)	Share of Farms (%)	Share of Total UAA (%)	Relative Share of Emissions (%)
Cattle	53.27	34	1,811	137.1	7.30	58	48	40
Overall	*91.37*	*42*	*3,283*	*198.1*	*18.10*	*100*	*100*	*100*

Table One: Cattle System and Overall emissions from Cattle, Dairy, Tillage and Sheep farms represented in the 2019 NFS.Source: Author's calculations based on a) Teagasc NFS Report 2019, Appendix One, Table Eight; and b) Teagasc NFS Sustainability Report 2019, Appendix One, Tables Five to Nine.

Specialist beef farms also have among the highest variation in CO2e emissions relative to output among agricultural systems in Ireland. The average emissions efficiency of cattle farming, as measured by kilograms of CO2e Agricultural GHG emissions per kilogram of live-weight beef produced, has fallen by 4% over 2015-2019, with relatively economically inefficient farms improving output emissions efficiency at the fastest rate within this period at 12%[12]. The NFS Sustainability report evidences the association between economic efficiency and emissions efficiency. Further research is required to explore what is driving trends in emissions efficiency, however.

Promoting informed on-farm decision-making and best practices can, though, create greater convergence among economically poorer-performing farms with relatively efficient farms, supporting environmental efficiency. The gap in emissions efficiency between the economic top and bottom thirds of cattle farms, per kg of beef, has fallen to a three-year average of 5.0kg within 2017-19, compared to 6.9kg in 2015, as seen in Table Two:

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[11] Author's calculations derived from average farm UAA and agriculturally generated emissions in Buckley, C. and Donnellan, T. (2020) *Teagasc NFS Sustainability Report 2019*. See Appendix A for full calculations and methodology. Emissions estimates aggregated by the number of farms represented in the 2019 NFS using system shares of farm population. Farms with < €8,000 in Standard Output are excluded – which are generally cattle or sheep farms. Total sector emissions (excl. Fuel) were 20.48MT CO2e in 2019, however, so the overall estimate of 18.1MT for farms represented in the NFS equates to c. 88% of total sector emissions. This overall total is the sum of Cattle, Dairy, Tillage and Sheep systems NFS estimates.

[12] Based on data in Teagasc *National Farm Survey Sustainability Reports* 2014-2019, Appendix One, Table Six.

Average Kg CO2eq Emissions per Kg Beef	2015	2017	2018	2019	Average 2017-19	% Change 2015-2019
Bottom Third	16.7	14.9	14.5	14.7	14.7	-12
Mean Average	12.2	12	12.1	11.7	11.9	- 4
Top Third	9.8	9.6	10.1	9.4	9.7	- 4
Bottom-Top Gap	*6.9*	*5.3*	*4.4*	*5.3*	*5.0*	*-23*

Table Two: Emissions Efficiency of Cattle Farming in Ireland 2015-19. Calculations based on data in Teagasc National Farm Survey Sustainability Report 2019, Appendix One, Table Six. Data not available for 2016.

Arising from these economic and environmental challenges, a number of DAFM policies have been implemented to provide support for the viability and sustainability of beef production. €300 Million was made available over a number of years under the current Rural Development Programme co-funded by the Exchequer, for the Beef Data and Genomics Programme (BDGP). In addition, over recent years, over €200 million of supports were made available specifically to the beef sector – including the Beef Environmental Efficiency Pilot (BEEP) in 2019; and Beef Environmental Efficiency Programme – Sucklers (BEEP-S) in 2020. This also includes the Beef Exceptional Aid Mechanism (BEAM), which provided partial compensation for depressed producer prices arising from Brexit and the necessary reduction in production or restructuring of the beef sector; and the Beef Finishers Payment (BFP) which provided partial compensation for depressed prices arising from the impact of the Covid-19 pandemic. Further, the Beef Sector Efficiency Pilot – with an allocation of €45 million, including €40m for the continuation of BEEP-S – was launched in 2021. An additional €6m is also being made available for Bord Bia to market Irish suckler beef abroad. The common purpose among these schemes is to incentivise actions which can improve the knowledge base and generate data to inform decision-making; this can, in turn, incrementally improve the economic and environmental performance of the suckler cow (beef) herd.

Beef Environmental Efficiency Programmes

BEEP-S is a voluntary scheme funded by the national exchequer and operated by DAFM. It aims to increase the economic and environmental efficiency of the suckler herd through improved data quality on cattle performance, aiding farm-level decision making in support of best practice in welfare management and breeding. This ties into the overall environmental objectives of DAFM as laid out in Ag-Climatise[13]. By increasing economic

[13] DAFM (2020) *Ag-Climatise: National Climate and Air Roadmap for the Agriculture Sector*, p.12:

"Animal Breeding has been identified as a concrete action that will not only reduce the environmental footprint on farm but will also increase farm profitability. [...*B]reeding can make a huge contribution to more carbon efficient animals. The ICBF beef Eurostar index, supported by schemes from the Department such as the Beef Data and Genomics Programme (BDGP) and the Beef Environmental Efficiency Programme (BEEP), have underpinned these improvements".*

efficiency, the scheme can also support profitability across beef farms which have been shown to be the lowest in the agriculture sector in consistent Teagasc NFS reports[14].

BEEP(-S) aims to promote measures which support cost and emissions savings. Three mitigation measures which are available to BEEP(-S) participants – improving maternal beef traits, live-weight gain and animal health – are recognised in the Teagasc Marginal Abatement Cost Curve (MACC) as net cost-saving, at the producer level, per tonne of CO2e abated[15]. These abatement costs do not account for significant public spending through programmes such as the BDGP, but indicate economic gains are possible for producers in tandem with greater emissions efficiency and improved animal health.

Weaning efficiency was targeted by BEEP-S in particular as it has been recognised as a key indicator of suckler beef performance, given the single unit of output (calf live-weight gain) which typically determines the efficiency of the system[16]. Weaning efficiency is the adjusted 200-day weight of a calf as a percentage of the adjusted 200-day post-calving weight of its dam (mother), capturing relative performance. BEEP-S addressed the data gap around animal weight, which was identified as BDGP matured, as well as gaps in knowledge around tracking of animal health. Such metrics can be used to inform breeding decisions on farms. This focus on these measures may also support scheme accessibility for smaller farmers, who cumulatively hold a significant proportion of livestock but may not participate if the scheme is considered overly complex.

This information is fed into the live-updated National Herd Dataset (NHD), informing the €uro-Star Replacement Index (RI) and enabling timely policy decisions as new data become available and trends emerge. Cows rated higher in genetic merit are relatively lighter but produce a heavier calf at weaning. The lower weight of the cow is particularly relevant as heavier cows require additional feed which incurs an additional cost for profitability and increases CO2e emissions output, whereas a heavier calf will generate a higher value output and lower emissions per kilogram of beef. The availability of this information to producers, through a Weaning Performance Report, enables informed decision-making around breeding at an individual animal level. Further optional measures available to BEEP-S participants relate to animal health, which aim to maintain animal performance and therefore limit emissions accruing to reduced capacity or mortality due to poor health.

BEEP(-S) is one tool, within a broader context, aimed at creating greater climate and economic resilience in the beef sector. The scheme is informed and aided by other

[14] Teagasc (2021) *National Farm Survey Reports* 2015-2020

[15] Improved live-weight gain, maternal beef traits and animal health are estimated to have marginal abatement savings per tonne of CO2eq of €600, €215 and €46, respectively in Lanigan, G. et al (2019) *Marginal Abatement Cost Curve for Irish Agricutlure 2021-2030*. Teagasc

[16] McHugh, N., Cromie, A.R., Evans, R.D. and D.P. Berry (2014) *Validation of national genetic evaluations for maternal beef cattle traits using Irish field data* in Journal of Animal Science **92**(4): 1423-1432.

measures, particularly the Beef Data Genomics Programme (BDGP). Together, these measures aim to create a national herd in which maternal cattle are healthier and lighter, producing heavier and more resilient calves. Over time, improving animal efficiency compounds and results in lower maintenance feed input and increasing average daily live-weight gain, enabling lower emissions per unit of output. This translates to lower costs for farmers, higher margins per unit of beef produced and more emissions-efficient output as higher-rated cattle become predominant[17]. The measures incorporated in BDGP and BEEP-S have been recognised internationally as best practices which can aid the development of beef systems sustainability[18]. The implementation of precision farming practices[19] using performance & genetic data from integrated databases – such as that collected through BEEP-S and BDGP and collated in the NHD – is also recognised as having significant potential to reduce environmental impacts and resource use, and to improve production efficiency[20].

A cumulative c. €95m was committed to BEEP-S and its predecessor pilot scheme over three national budgets between 2019-2021:

Year	Scheme	Abbreviation	Funding Allocation
2019	Beef Environmental Efficiency Pilot	BEEP	€20m
2020	Beef Environmental Efficiency Programme – Sucklers	BEEP-S	€35m
2021	Beef Environmental Efficiency Programme – Sucklers[21]	BEEP-S	€40m

Table Three: Overview of recent Beef Environmental Efficiency programmes 2019-2021.

Payment rates were based on estimates of costs incurred and income forgone excluding any economic gains. The 2019 pilot paid a flat €40 per verified pair of cow/calf weights submitted. The 2020 scheme included the same compulsory requirement for weighing cow/calf pairs prior to weaning, but at a rate of €50 for the first ten pairs and €40 thereafter up to a maximum of 100 pairs. The 2020 scheme also added optional measures for (a) meal feeding at weaning, or vaccination; and (b) faecal egg testing. These measures were valued

[17] Absolute emissions reductions require sufficient uptake and (at least) stable cattle numbers.
[18] The Scottish Government (2020) *Beef Report 2020*, pp.12-29. This expert panel report recognises Ireland as a leader in the collection and use of cattle data to improve beef systems sustainability in its proposals: *"Access to accurate weigh scale facilities for every beef farmer in Scotland should be the ambition of our sector [...] Experience from the Republic of Ireland demonstrates the value to producers of such a database. As the database matures, producers can see that the value of the data increases with the quantity and accuracy of the input data [...]An enhanced level scheme could incorporate genetic (DNA) data and animal health data.*

[19] [19] Precision farming is a "management approach that focuses on (near real-time) observation, measurement and responses to variability in crops, fields and animals" and can increase "animal performance, reduce costs, including labour costs, and optimise process inputs" according to the EU Commission EIP-AGRI agency.
[20] UK Department for Environment, Food and Rural Affairs (DEFRA) (2021) *Enabling genome-enhanced precision farming by building on traceability.*
[21] The 2021 BEEP-S was part of the Beef Sector Efficiency Pilot alongside the Dairy-Beef Calf Programme, which supports beef farmers who are rearing calves from the dairy herd.

at a payment rate of €30 per cow/calf pair for option (a); and €10 per cow/calf pair for option (b). Payment front-loading aimed to encourage smaller farms to participate in the scheme, learning from the disproportionately larger farms who participated in the 2019 pilot. The 2021 BEEP-S programme continues the same measures and payment structure. The Programme is operated on a voluntary basis and is open to all valid Basic Payment Scheme clients with beef-bred suckler cows born within a backward-looking reference period.

This paper will examine the data generated by the scheme to date. While a longer time frame is necessary to capture comparative data at herd level and the impact on breeding decision-making, the review will present preliminary trends and project likely impacts into the future. This spending review examines BEEP-S using the following criteria:

1) Alignment
    - Review the ongoing relevance of BEEP to DAFM objectives in line with other schemes (e.g. BDGP), and strategies, (e.g. *Ag-Climatise);* and

2) Efficiency
    - Examine the application rate, participation rate, draw-down of allocation, and cross participation across schemes targeting the beef sector;
    - Determine the level of adoption of additional measures within the scheme;
    - Assess the rate of compliance with the conditions of the scheme; and

3) Effectiveness
    - Establish early indications of outputs from the scheme to date.
    - Evaluate the scheme to determine if preliminary trends are in line to deliver the intended impacts in the medium-to-long term.

This paper is set out in sections as follows:

- Section Two will develop the wider policy context and Spending Review rationale;
- Section Three outlines the development of beef sector supports and BEEP(-S);
- Section Four analyses the available data to map the preliminary trends with the expected longer-term benefits;
- Section Five concludes and offers some recommendations from the paper.

Methodology and Limitations

The review follows the principles of the Spending Review process and focuses on the delivery on the BEEP-S objectives. The research was desk-based, employing a mixed-methods methodology using a Programme Logic Model, to evaluate the following:

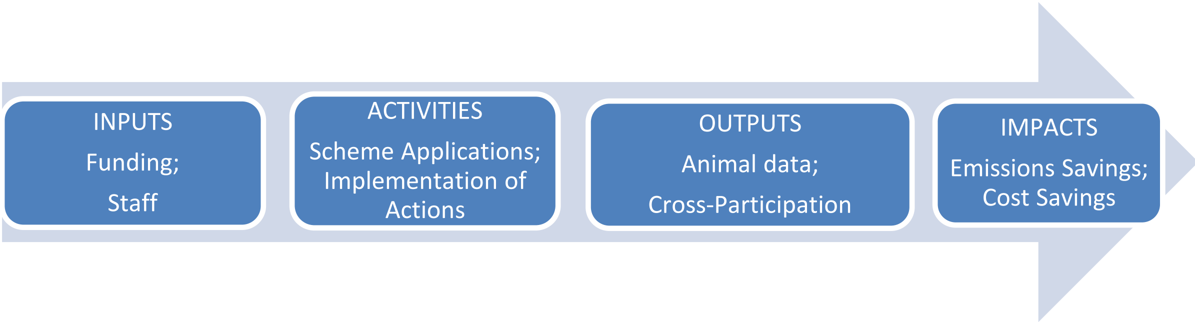

Figure One: Programme Logic Model, including examples relevant to this evaluation.

The spending review itself can be thought of as positioned between steps three and four, to ensure the programme can deliver the intended impacts in the medium- to long-term. The review was led by the Economics and Planning Division (EPD) in DAFM, in conjunction with colleagues in other divisions within DAFM and the Irish Cattle Breeders Federation (ICBF). The analysis provides a statistical evaluation of relevant indicators recorded to date in the National Herd Database (NHD). This enables the setting of benchmarks against which to measure anticipated future impacts of the programme and the identification of any areas of delivery which could be improved in terms of access, efficiency, or efficacy.

Due to the recent implementation of the scheme, it is too early to evidence fully realised benefits or trends in outputs from the scheme; caution is therefore urged in inferring headline trends from the data presented here. While the themes touched on in this evaluation are highly relevant to the sector as a whole and this context is provided below – in terms of socio-economic sustainability and climate action – wider concerns beyond BEEP-S objectives are outside the scope of this paper. It should also be noted that the International Panel on Climate Change (IPCC) emissions calculation framework is used throughout this paper[22].

2. Context

2.1 Beef Sector

The Irish beef sector primarily comprises of 78,300 specialist beef farms[23], generating €2.3bn in output[24] and representing 16% of total agri-food export value in 2020. This

[22] This approach recognises that national emissions inventory accounting, which is the basis for our statutory climate action obligations, uses this internationally-established methodology The IPCC Fourth Assessment Report (AR4) standard methodology for estimating emissions, namely Global Warming Potential (GWP^{100}), uses a 100-year reference period to assess the warming impact of carbon-equivalent emissions; whereby carbon dioxide has a reference value of one and methane has a multiplier of 25. This reflects the radiative forcing potential of methane as a potent Short-Lived Climate Forcer (SLCF). Alternative methodologies have been proposed, e.g. GWP* in Allen, MR et al (2018) *A solution to the misrepresentations of CO2-equivalent emissions of short- lived climate pollutants under ambitious mitigation* in Climate and Atmospheric Science, 1(1), 16. GWP* reflects the differing warming impact of short-lived non-CO2 GHG pollutants such as methane on the atmosphere and therefore emphasises the rate of change, whereby short-term changes have a much larger impact on the warming impact calculation than would be estimated under GWP^{100}, with a multiplier of 84. This reflects the fact that methane is cycled out of the atmosphere within approx. 10-12 years.

[23] CSO (2018) *Farm Structure Survey 2016*. Non-dairy cattle are common in other farm systems (e.g. tillage).

reflects the comparative advantage afforded to Irish grass-based beef production by a temperate climate, which leads to comparably high grass growth rates which, in turn, support relatively lower production costs and distinct beef quality characteristics that ensure Irish produce is internationally competitive[25] Beef output also has a high multiplier value of c. 2.5 in Ireland[26]. The sector plays a significant role in rural development and provides an employment outlet in regions with relatively fewer alternative economic opportunities; specialist cattle farming is concentrated in the Border-Midlands-West region, where agri-food represents one in eight jobs compared to one in twelve jobs nationally[27].

As evidenced by successive Teagasc NFS reports, specialist beef farms, in general, are relatively smaller in terms of land and livestock units held; households are, on average, older and more likely to have off-farm employment; and part-time farming is more prevalent. This is evidenced below by preliminary data from the 2020 Teagasc NFS:

Topic	Metric	Cattle Rearing	Cattle Other
Farm Size	Utilised Agricultural Area (UAA) in Hectares (Ha.)	30.8	36.8
	Total Livestock Units	35.2	46.7
Off-Farm Income	Farm Holder has Off-Farm Job (% Households)	42.3	37.3
	Household Member has Off-Farm Job (% Households)	57.1	49.4
	Pension Income (% Households)	35.0	38.9
	Unemployment Benefit etc. (% Households)	6.4	5.6
Household Demographic Sustainability	Average Age of Farm Holder	58.7	61.6
	Household Size (No. Persons)	2.4	2.5
	Of which < 24 years of age	*0.4*	*0.5*
	% Demographically Viable (One member aged < 45)	53.5	47.0

Table Four: Indicators from Teagasc NFS Preliminary Results 2020 for Farm Size, Off-Farm Income sources and Demographic Sustainability for Beef Farm (Cattle Rearing and Cattle Other) Households.

The number of 'other' (non-dairy) cows has fallen c. 23% from the most recent high-point of 1.22m in June 2008 to 0.94m in June 2021, and is projected to fall further to 2030[28], while

[24] CSO (2021) Agricultural Output, Input and Income, Table AEA01.
[25] Teagasc (2020) *Growing your potential: Grass-to-Beef;* Teagasc (2021) *Grass 10 Report 2017-2020*

[26] 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
[27] CSO (2018) *Farm Structure Survey 2016*.
[28] Buckley, C. et al (2020) *An Analysis of the Cost of Abatement of Ammonia Emissions in Irish Agriculture in 2030.* Teagasc. Range of low to high activity levels, Common Agriculture Policy (CAP) and trade assumptions give an estimated level of between 690,000 to 910,000 Other Cows at 2030.

the aggregate value of output from the beef sector has continued to expand in spite of this[29]:

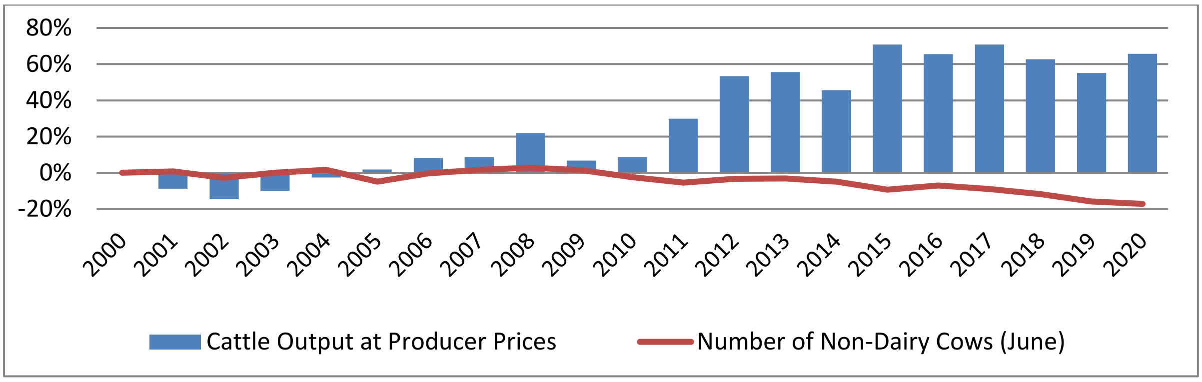

Figure Two: Percentage Difference compared to 2000 for Cattle (Beef Sector) Output at Current Prices and the Number of Other (Non-Dairy) Cows. Author's Calculations based on CSO Livestock Survey and CSO Output, Input and Income in Agriculture. 'Cattle Output' derives from both beef and dairy systems – including slaughtering, net live exports and change in stocks.

This indicates improving output efficiency over time at the aggregate level. There are, however, challenges for profitability on the revenue and cost side. For instance, there is significant year-to-year volatility in beef prices, with 2019 and 2020 prices generally 3% and 4% below the five-year average, respectively, while 2021 prices are generally c. 6% above the 2016-20 five-year average to date:

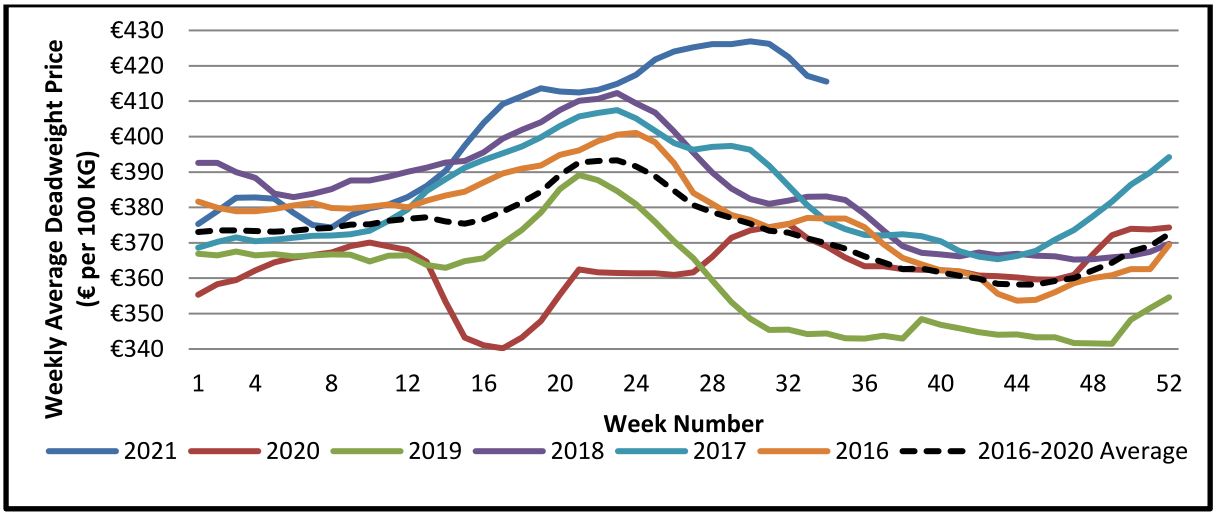

Figure Three: Weekly Deadweight Price per 100 KG Beef (R3 Steers) in Ireland January 2016- July 2021. Source: DAFM Weekly Meat Report. Note: Price excludes VAT.

Further, input costs have generally remained stable but high relative to output. Average total net expenses as a percentage of gross output were, for cattle rearing farms, the highest in the agriculture sector in 2020 – averaging 79.5%[30]. Generally, over time, an

[29] CSO (2021) June Livestock Survey, Table AAA09; and CSO (2021) Output, Input and Income in Agriculture.
[30] Based on figures in Teagasc (2021) *National Farm Survey Reports* 2015-2020, Table 8D. This figure excludes farm family labour and varies by size, at 66% for cattle farms of 50-99 ha. in size, to 94% for those smaller than 20 hectares in 2019. This suggests economies of scale for relatively larger farms up to a certain point, with

increasing proportion of Cattle Rearing (CR) farms report a ratio of > 70% by this measure of sustainability. This may be reversing somewhat, however, according to provisional 2020 NFS figures. Mean total net expenses for Cattle Rearing farms averaged €27,700 between 2015-20, relatively consistent over time, however their composition can alter from year-to-year.

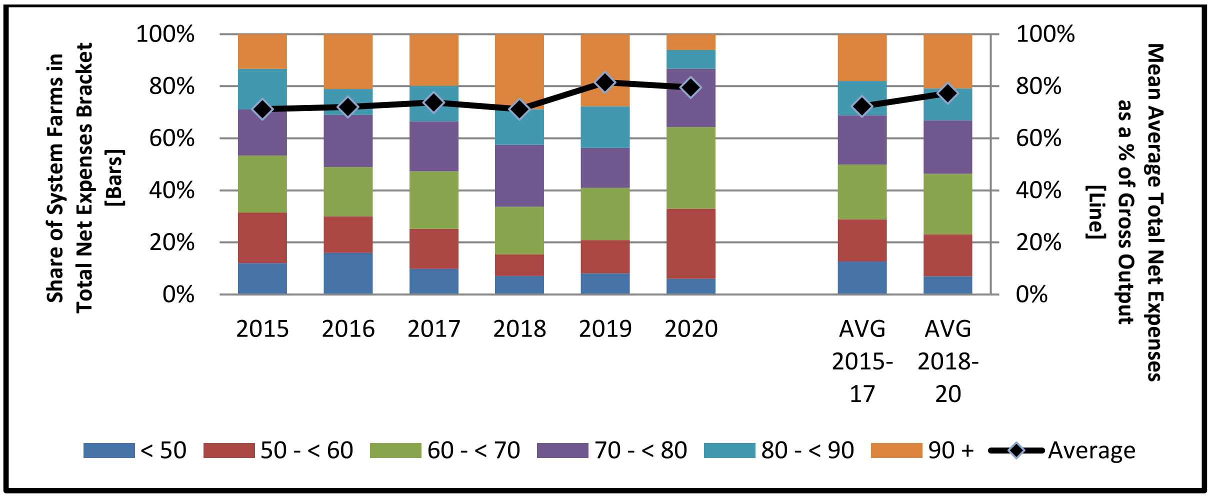

Figure Four: NFS 2015-2020 Table 08D – Distribution of Cattle Rearing Farms by Brackets of Total Net Expenses as a percentage of Gross Output (Left-Hand Axis); and Overall Mean Average Total Net Expenses as a percentage (%) of Gross Output (Right-Hand Axis). Stacked bars correspond to brackets of Total Net Expenses as a % of Gross Output.

Year-on-Year Change in Expenses (%)	2016	2017	2018	2019	2020	Overall Change 2020 vs. 2015 (%)
Direct Costs	4.2	6.9	-3.0	-7.2	0.6	0.9
Overhead Costs	-3.0	5.6	-6.1	6.3	-3.5	-1.2
Total Net Expenses	0.3	6.2	-4.6	-0.2	-1.6	-0.2

Table Five: Year-on-Year variation, compared to previous year, in Expenses of Cattle Rearing farms 2015-2020; and Overall Percentage Change in Costs, by type, 2015-20.

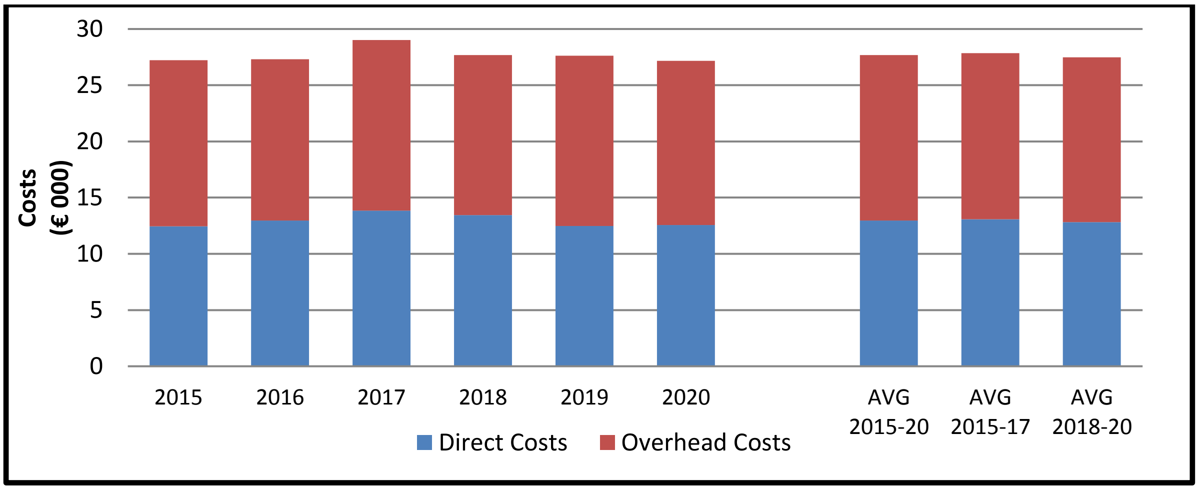

Figure Five: NFS 2015-2020 – Cattle Rearing Trends in Costs (€ 000, LHS) and Year-on-Year Variation (%, RHS)

diminishing returns above 100 hectares. No sampling in 2018 of farms =/>100 hectares. There is greater uncertainty around estimates for very small (<20 ha.) and very large (=/>100 ha.) farms due to low sampling.

Reliance on Direct Payments is similarly a challenge for cattle systems; Cattle Rearing and Cattle Other (CR and CO) farms had a mean annual ratio of Direct Payments (DPs) to Family Farm Income (FFI) of 135% and 107% within 2015-20, respectively[31]. This means that absent DPs, these farms would be making a net loss. DPs are comprised of several sources, the largest of which is generally the Basic Payment Scheme (BPS) which is paid per eligible hectare of land but is decoupled from production[32]. The value of direct payments trended downward within 2015-17; however, after BEEP and the Beef Exceptional Aid Measure (BEAM) were introduced in 2019, and BEEP-S was implemented in 2020, cattle farm DPs tended toward their medium-term averages[33]. Each Euro of Direct Payments to beef farms is estimated to have a total economic impact of at least €4 in the domestic economy[34]. DPs are larger on Cattle Other farms, in absolute terms, but comprise a larger share of Family Farm Income on Cattle Rearing farms.

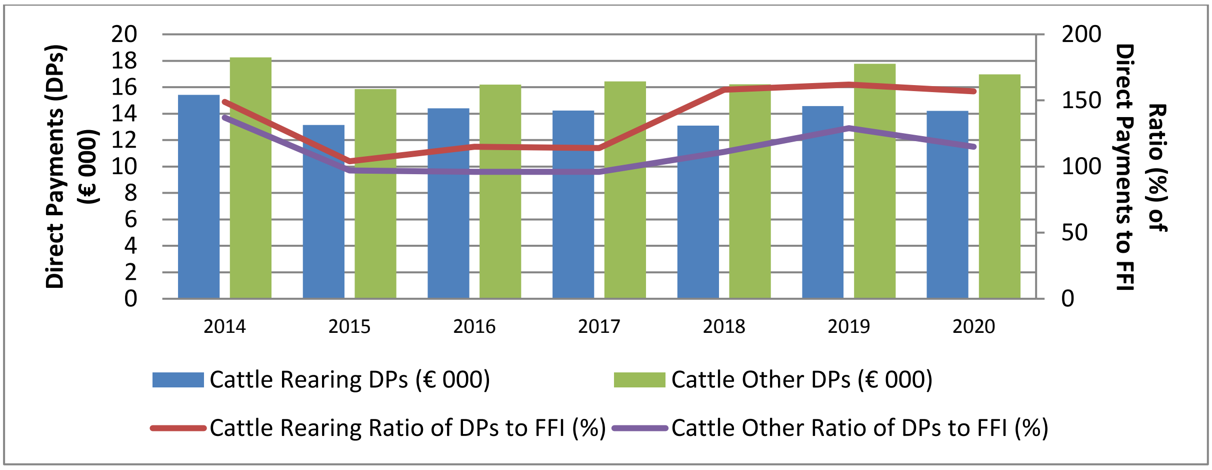

Figure Six: Teagasc NFS (2015-2020) Cattle System Nominal Cattle Direct Payments (Thousands of Euros) and Percentage (%) Contribution of Direct Payments to FFI

42% and 37% of CR and CO farm holders, respectively – and more than half of all beef farm households (i.e., farm holders and/or a member of their family) – have income from off-

[31] Author's calculations based on figures in Teagasc (2021) *National Farm Survey Reports* 2015-2020 Table 08A. A ratio of greater than 100% for [DPs : FFI] indicates direct payments are effectively subsidising a net farm loss.

[32] Other payments include the Green Low-Carbon Agri-Environmental Scheme (GLAS) which provides payments for environmentally-friendly farming practices; the Areas of Natural Constraint (ANC) scheme which provides payments to people farming in designated disadvantaged areas to compensate for additional costs associated with farming such land; and the Young Farmers (YF) scheme which pays farmers under the age of 40 who are educated in agriculture for up to five years if their off-farm income is less than €40,000 per annum. Sector-specific schemes, such as BDGP and BEEP-S are paid for completion of actions in line with best practices, such as genotyping and weighing of cattle.

[33] Direct Payments increased 11% and 10% in nominal value from 2018-2019 for Cattle Rearing and Cattle Other farms, respectively, in Donnellan, T. and Buckley, C. (2020) Teagasc NFS 2019 Report. The report, on page seven, cites "increased supports made available to offset low cattle prices", i.e. the BEEP pilot and the Beef Exceptional Aid Measure (BEAM), as the key determinant of a 6% aggregate increase between 2018-2019 in Direct Payments for farms represented in the NFS. Preliminary 2020 NFS data suggests BEEP-S payments were worth an average of approx. €1,000 to farm income on Cattle Rearing and Cattle Other farms.

[34] Hennessy, T., Doran, J., Bogue, J. and Repar, L. (2018) *The Economic and Social Significance of the Irish Suckler Beef Sector,* p.39.

farm employment[35]. Overall, Cattle Rearing systems are smaller, offer lower economic returns compared to other agricultural systems and reliance on direct payments is, as a result, more prevalent. Real-terms mean average FFI – which includes direct payments – is shown below over 2014-19 for primary Irish agricultural systems, evidencing the relatively low returns to farming among dry-stock (Cattle Rearing, Cattle Other and Sheep) systems[36]. This shows an average of €11,131 over the six-year period for Cattle Rearing farms.

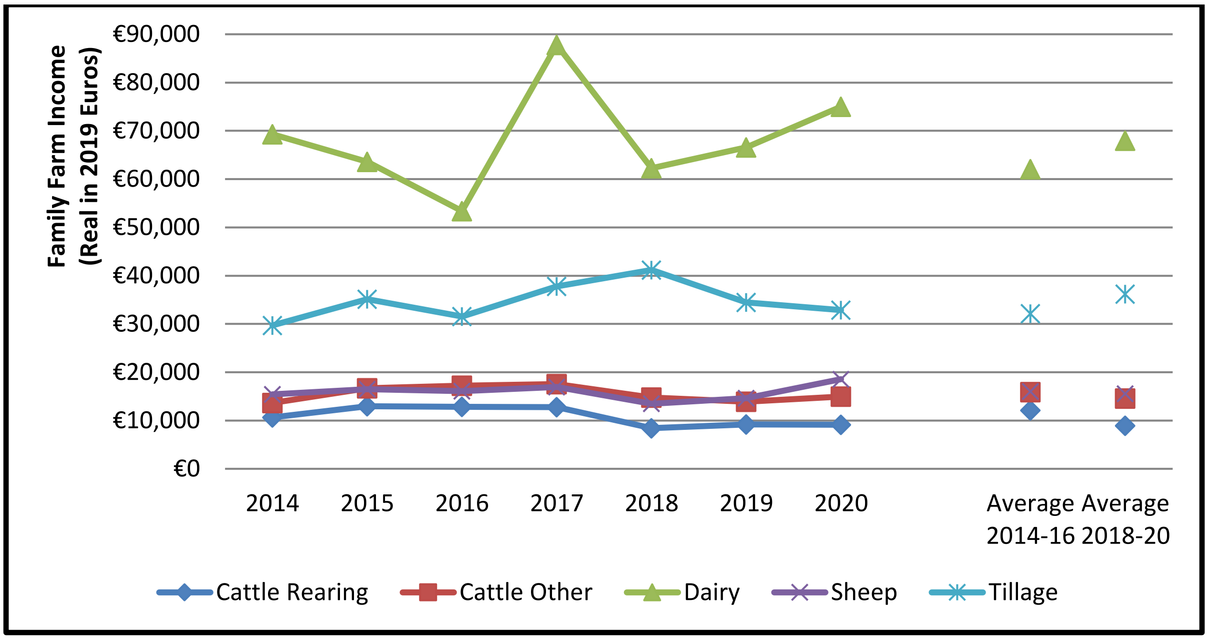

Figure Seven: Real-Terms Mean Average Family Farm Income 2014-20 in December 2019 Euros. Author's calculations using NFS (2014-20) data, converted to December 2019 Euros using the CSO CPI converter tool.

Real Average FFI (€)	2014-2016	2015-2017	2016-2018	2017-2019	2018-2020	Change (€) 2016-20	Change (%) 2016-20
Dairy	62,082	68,271	67,821	72,217	67,932	5,850	9%
Tillage	32,128	34,820	36,845	37,802	36,156	4,028	13%
Sheep	16,010	16,506	15,491	15,000	15,547	- 463	-3%
Cattle Other	15,867	17,168	16,517	15,398	14,535	- 1,332	-8%
Cattle Rearing	12,131	12,851	11,339	10,131	8,912	- 3,219	-27%

Table Six: Rolling Three-Year Average Family Farm Income in December 2019 Euros. Source: Author's Calculations using NFS 2014-2020 data, converted from nominal values using the CSO CPI converter tool.

Specialist dry-stock (beef and sheep) farms are clustered toward the lower end of the size distribution in terms of hectares per holding, as illustrated in the graph below. The average specialist beef farm was 26.5 ha. in the latest (2016) CSO Farm Structure Survey, compared to 59.2 ha. for the average specialist dairy farm; 69% of specialist cattle farms were less than

[35] Donnellan, T. and Buckley, C. (2021) Teagasc NFS 2020, Table 08 (E).

[36] Author's calculations using Teagasc NFS Report (2014-19) data, converted to December 2019 Euros using the CSO Consumer Price Index inflation converter tool.

Donnellan, T. and Buckley, C. (2020) 2019 NFS: "*Family Farm Income is gross output less total net expenses; it represents the total return to the family labour, management and capital investment in the farm business*".

30 ha., compared to 16% of dairy farms. FFI generally increases with farm size, however, there is large variance across individual farms[37].

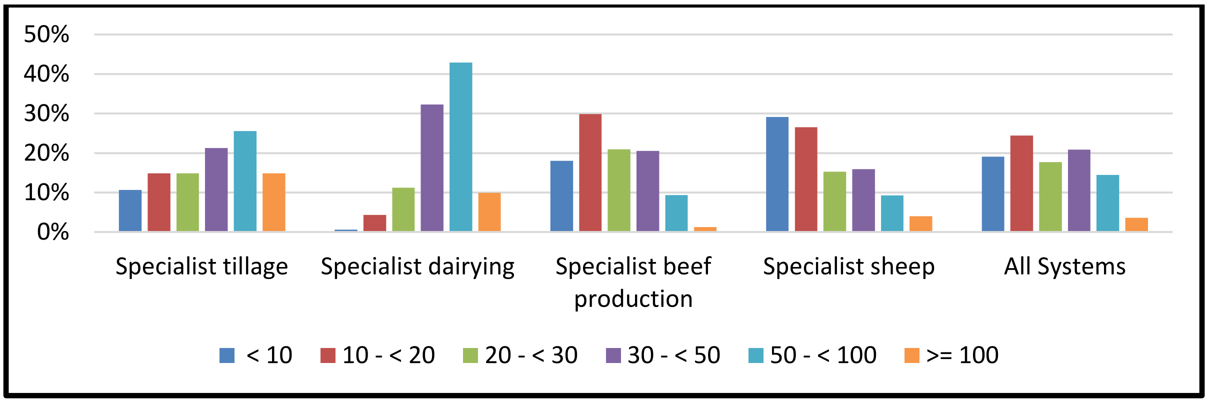

Figure Eight: Distribution of Systems across Size Brackets of Hectares of Utilised Agricultural Area (UAA).Brackets are exhaustive (i.e. columns sum to 100% within each system). Source: 2016 CSO Farm Structure Survey, Table 2.4

The sector also faces challenges in the near term around disruption arising from the Covid-19 pandemic, as well as the shock to export conditions arising from the Trade & Co-Operation Agreement (TCA) governing EU-UK trade which came into force in January 2021. Approx. 90% of Irish beef is exported annually, with exports to the UK accounting for over €1bn in value or 43% of Irish beef export value in 2019[38]. In the context of the comparatively long production cycle of extensive beef systems, this represents a vulnerability to any adverse demand shock or displacement of UK demand for Irish beef.

2.2 Environment and Climate

The need to ensure food security and rural economic vitality must be considered within the context of environmental impacts and climate risks. Sector sustainability will require social, economic, and environmental balance as illustrated by reference to sustainable intensification in the 2030 EU Climate and Energy Policy Framework, recognising the important role of producers in climate action[39]:

"Sustainable intensification leverages the strengths of the sector by improving productivity while using natural resources in a manner which protects them into the future [...] Environmental protection and economic competiveness will be considered as equal and complementary, one will not be achieved at the expense of the other."

As a member of the EU, Ireland's target to reduce emissions – in line with the Paris Agreement – is guided by the EU Climate and Energy Framework. Ireland has committed, under the 2018 Effort Sharing Regulation (ESR), to reduce overall GHG emissions by 30% by 2030 relative to 2005. This is likely to increase further as part of the 'Fit for 55%' plan, which

[37] Donnellan, T. and Buckley, C. (2020) *Teagasc National Farm Survey 2019*, Figure 23.
[38] DAFM (2020) *Annual Review and Outlook 2020*, p.88.
[39] Department of Agriculture, Food and the Marine 2015 – Food Wise 2025 Strategic Environment Assessment Non Technical Summary, p.7

increased overall EU ambition to reduce emissions by 55% relative to 1990 levels by 2030. Ireland's commitments under ESR are being implemented through the National Climate Action Plan 2019, which includes a target of a 10-15% reduction in agriculture sector emissions by 2030 relative to the baseline[40]. In practice, this will mean reducing emissions to c. 17.5-19 million tonnes of CO2eq per annum by 2030. Total agriculture sector emissions[41] were 21.15MT CO2eq in 2019, down 3.9% from 2018; this translates to 35.3% of overall national GHG emissions[42]. Ireland ranked as the sixth largest emitter of agricultural GHG emissions among the EU-27 in 2018, contributing 5% of total EU agricultural emissions[43].

The 2019 National Climate Action Plan (NCAP) is the framework for achieving the statutory GHG emission reduction targets while transforming the Irish economy and society towards climate-resilient and holistically sustainable development. The EU Green Deal, including the Farm-to-Fork[44] and Biodiversity Strategies[45] toward 2030, has added impetus to climate action in agriculture – with the EU Methane Strategy highlighting opportunities in animal diets, herd management and animal management, as well as breeding, herd health and animal welfare[46]. Meanwhile, the new Common Agricultural Policy will include greater funding for agri-environmental measures through eco-schemes from 2023[47]. Further, the 2021 Climate Action and Low Carbon Development (Amendment) (CALCD) Act[48] provides a framework to achieve net-zero climate-neutral economy by 2050[49]. This will be secured by enabling an independent Climate Change Advisory Council (CCAC) to propose successive five-year 'carbon budgets', which Government must accept or accept with amendments, and approval by the Oireachtas is required. Carbon budgets will be translated into sectoral emissions ceilings for relevant Ministers by the Minister for Environment, Climate and Communications. Ag-Climatise is the roadmap toward a low-carbon agriculture sector, informed by the Teagasc Marginal Abatement Cost Curve (MACC) in particular. The NCAP is currently being updated to reflect heightened ambition, while Ag-Climatise is a living document which can be adjusted to reflect new evidence, knowledge, or ambition.

Each of these frameworks has recognised the socio-economic significance of agriculture and food production in Ireland, while the 2021 CALCD Act recognises the distinct characteristics

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[40] Department of Environment, Climate and Communications (2019) *National Climate Action Plan 2019*, p.102

[41] Agriculture emissions are primarily the product of enteric fermentation, manure management, agricultural soils, liming, urea application, agriculture & forestry fuel combustion and fishing for the purposes of national emissions inventory accounting under the IPCC methodology. This is measured in carbon-equivalents using the Global Warming Potential metric over a 100-year timeframe (GWP^{100}).

[42] Author's calculations using EPA (2020) *Provisional estimates of Ireland's GHG emissions 1990-2019*.

[43] Author's calculations based on Eurostat data *Greenhouse Gas Emissions by Source Sector (source: EEA): Agriculture (CRF3)/Total Greenhouse Gas Emissions/EU27*

[44] EU Commission (2020) *Farm to Fork Strategy*.

[45]EU Commission (2020) Biodiversity Strategy.

[46] EU Commission (2020) *An EU Strategy to Reduce Methane Emissions*, p.12.

[47] EU Commission (2021) *The future of the Common Agricultural Policy*

[48] Climate Action and Low Carbon Development (Amendment) Act 2021, enacted 23/07/2021.

[49] Climate neutrality is defined as balancing agricultural emissions with carbon sequestration, reducing emissions from land use, increasing fossil fuel displacement and energy intensive materials displacement.

of biogenic methane. The sector must reduce its absolute carbon-equivalent GHG emissions and maximise the off-setting of residual emissions through carbon sequestration – including land use solutions such as reforestation or afforestation, and fossil fuel displacement such as bio-fuel production. Food Vision 2030, the agriculture and food sector development strategy, also acknowledges the holistic nature of sustainability by using a Food Systems approach. This will ensure the sector, through a long-term vision and in its totality, is profitable, provides broad-based benefits for society, and has a positive or neutral impact on the natural environment[50].

The Teagasc Marginal Abatement Cost Curve (MACC) is a histogram of the gross abatement potential of GHG emissions mitigation measures available in terms of their cost efficacy for producers[51]. Together, these can cumulatively achieve the emissions reductions set out in the NCAP at requisite levels of up-take and assuming constant animal numbers. Agricultural Knowledge and Innovation Systems (AKIS) will therefore be crucial in securing up-take of sustainable measures and ensuring producers receive evidence-based advice to promote actions which are predominantly of mutual environmental and socio-economic benefit. The MACC measures of primary relevance to the beef sector are the net cost-saving efficiency measures, at the producer level, of a) improved live-weight gain, and b) improved beef maternal traits. These measures have been targeted through the BDGP and BEEP-S programmes to date. The optional measures available under BEEP-S targeted at improving animal health also have cost-saving abatement potential, whereby reduced disease incidence can maintain productivity through reduced illness and mortality.

While the above measures are cost-saving at producer level, this does not take into account the significant national expenditure provided to support their implementation. It is also important to consider unintended rebound effects from efficiency gains due to the supply-side response of producers to increased profitability – whereby absolute emissions could increase due to higher overall production levels, partially or entirely negating emissions intensity improvements[52]. For this reason, BEEP-S, similar to BDGP, was designed to limit the number of eligible animals as it only pays on the basis of costs incurred and income forgone, and caps payments for the number of cow/calf pairs.

Interaction of BEEP-S with Other Schemes

It is important to acknowledge other relevant beef sector schemes which contribute to the same or similar objectives as BEEP-S by targeting the economic and environmental efficiency of beef systems. Foremost, the BDGP promotes environmental resilience, economic productivity and aims to reduce GHG emissions per unit of output. Under previous modelling, cost savings and absolute emissions reductions are projected to

[50] DAFM (2021) Food Vision 2030.

[51] Lanigan, G. and Donnellan, T. (eds.) (2019) *An Analysis of the Cost of the Abatement of Greenhouse Gas Emissions in Irish Agriculture 2021-2030.* Teagasc.

[52] Ibid.

materialise from the scheme over time. This is achieved by "[improving] *the genetic merits of the national beef herd through the collection of data and genotypes of selected animals [...] for the application of genomic selection in the beef herd; and [lowering] the intensity of GHG emissions by improving the quality and efficiency of the national beef herd*."[53]

BEEP-S can be considered complementary to BDGP, as the actions undertaken differ from those in BDGP, but will yield a combined impact for participants of both schemes. Farmers who participate in BDGP and/or BEEP-S can make more informed breeding decisions based on the genetic traits in their herds through BDGP; and the performance-based indicators as determined by the weaning efficiency and the animal health of cattle within their herd through BEEP-S.

This interaction between the information provided through participation in these schemes feeds into a circularity of actions which, together, promote improved economic and environmental sustainability at both farm and aggregate levels. The BEEP-S and BDGP programmes are also complementary to a range of other schemes funded through the Rural Development Programme (RDP). This includes the Knowledge Transfer Programme, the Green Low Carbon Agri-Environmental Scheme (GLAS), the Targeted Agricultural Modernisation Scheme (TAMS) and the Organic Farming Scheme. BEEP-S is a supporting measure which specifically targets beef systems sustainability. This supports the policy priority of encouraging uptake of efficient breeding strategies, focusing on maternal traits, to deliver more climate- and resource-efficient cattle. The frameworks and mitigation actions mentioned here can deliver cumulative gains over time, through iterative improvements, with sufficient cattle population coverage. This will contribute to achieving absolute emissions reductions at the aggregate level if cattle numbers are at least stable.

2.3 Intervention Logic

Below, the rationale for government intervention is evaluated to:

a) Assess the basis for the measures in BEEP-S; and
b) Analyse how BEEP-S measures promote the provision of public goods.

<u>Data Generation and Dissemination</u>

The data from BEEP-S –which is added to the National Herd Dataset, analysed by ICBF and disseminated to farm level – can aid producers in making informed and timely decisions around animal health and breeding. Statistically weighted data in the NHD on animal performance, ancestry and genomics then determine the genetic value of a cow under the accessible and reliable €uroStar Replacement Index (RI) system. The RI follows the approach of the Economic Breeding Index (EBI) adopted in the dairy sector – where animals are classified by genetic merit – with the ultimate aim of creating a resilient and efficient herd

[53] Cawley, A. and Cronin, A. (2019) *Spending Review 2019: Beef Data Genomics Programme,* p.ii. DAFM.

as higher-rated cows become predominant. The RI equates to progressively increasing profitability along the groupings of cow efficiency, with ratings used as a predictor of future performance, reflecting variance in myriad factors such as size and temperament. BEEP-S adds value to the NHD, and therefore the RI, by appending performance-based data on weights and animal health indicators. Farm-level breeding decisions are then informed by these ratings, with the aim of replacing one- and two-star cows with, ideally, four- and five-star cows. Over time, this translates to a more efficient herd at the farm and national level, with cows becoming more resilient and productive.

As relatively inefficient cattle are incrementally replaced by lighter dams producing heavier and faster-growing calves, fewer cattle are required to produce the same quantity of output with accelerated production cycles. This translates to lower emissions intensities per unit of output to reduce environmental pressures and creates cost savings which aid profitability at the farm level. Improvements accrue gradually over time, with progressive momentum at an aggregate level as increases in the genetic merit of the national herd compound. Lower emission intensity gains per unit is a key part of achieving the environmental objectives for the sector but must be considered in the context of overeall emissions and therefore it is also important to consider any potential unintended effects as unit efficiency improves.

The importance of accurate evaluations can be seen in the evolution of replacement and terminal indices over time in the suckler beef herd[54]. In 2008, the Suckler Cow Welfare Scheme (SCWS) was introduced to improve data recording, focusing on welfare and terminal traits such as ancestry and phenotypes; the establishment of the Replacement Index in 2011 shifted the focus toward maternal traits. The 2015 introduction of the BDGP initiated genotyping to generate granular data which, when applied, could secure genetic gains for maternal traits over time. BEEP(-S) addressed a knowledge gap by providing data on cow weights, which is complimentary to the data available from BDGP in providing a performance-based metric which can be evaluated in conjunction with genetic information from the BDGP. A cumulative 2.5m cows have been genotyped to date, which has improved the accuracy of the data over time.

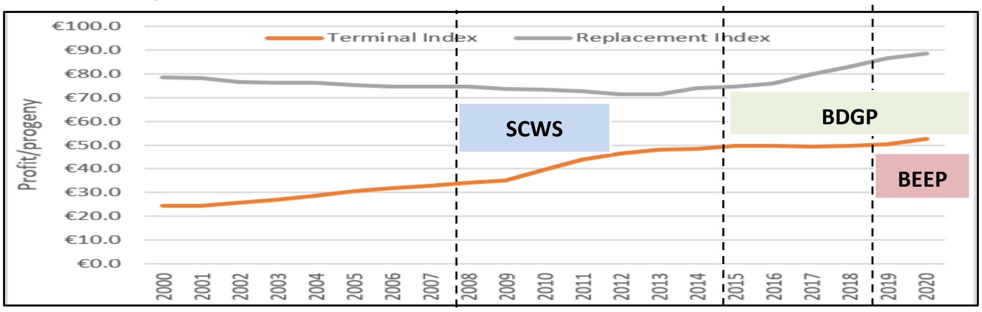

Figure Nine: Trends (Profit/Progeny) for Replacement and Terminal Indices based on suckler beef females by year of first calving Source: ICBF.

54 The Replacement Index estimates the suitability of females for calving ability, milk and fertility using independent variables relating to maternal traits; while the Terminal Index predicts the estimated profitability of progeny using data on liveweight; carcass conformation; and ease and efficiency of finishing.

Animal Health

Improvements in cattle health, particularly through prevention of illnesses, can reduce emissions per unit of output by maintaining productivity and welfare, reducing feed input requirements over the life cycle of the animal to produce the same quantity of output, and reducing the grazing period required to achieve the necessary live-weight gain[55]. There are economic and other benefits to the producer from prevention of illnesses in foregoing labour input requirements, treatment costs and mortality[56].

Respiratory infections, or Bovine Respiratory Diseases (BRD) – such as Bovine Viral Diarrhoea (BVD) – were the predominant cause of mortality diagnosed post-mortem among calves of between 1-12 months of age in Ireland in 2019, accounting for the cause of death in 30.6% (299) of the 977 animals submitted for post-mortem examinations in this age group[57]. Animals which require treatment for BVD, when compared to a reference healthy calf, have lower Average Daily live-weight Gain (ADG), require a higher number of feeding days, and have reduced feed efficiency, translating to excess emissions[58]. Lower performance of cattle infected by BRD – due to treatment costs and/or inhibited productivity from reduced physical capacity – has been estimated to have a mean cost to farms of between AUS $67 – $214 (c. €41-€129) per calf; while BRD mortality was associated with an economic cost of AUS $1,657 (c. €996)[59]. Cost-effective vaccination against BRD can therefore prevent animal discomfort and save labour, costs, productivity and, ultimately, GHG emissions.

Weaning is recognised as an especially stressful period due to changes which occur simultaneously around this time, such as in calf diet and housing, creating susceptibility to diseases such as pneumonia or BRD[60]. Meal feeding can reduce stress and therefore protect immune function and limit fall-off in live-weight gain post-weaning[61]. Finally, liver and rumen fluke are relatively rare but have significant potential to affect productivity. Among c. 3,900 tests completed for rumen and liver fluke in Ireland in 2019, less than 0.8% and 2.1% were positive, respectively[62]. Beef cattle infected with liver fluke have been estimated to be

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[55] Grossi, G., Goglio, P., Vitali, A. and Wiiliams, A. (2019) *Livestock and Climate Change: Impact of Livestock on Climate and Mitigation Strategies* in Animal Frontiers, Vol. 9, Issue 1, pp.69-76.

[56] Ozkan, S. Ahmadi, B.V., Bonesmo, H., Osteras, O., Stott, A. and Harstad, M. (2015) *Impact of Animal Health on Greenhouse Gas Emissions* in Advances in Animal Biosciences, Vol. Six, Issue One, pp.24-25

[57] Agri-Food & Bio-Sciences Institute and DAFM Veterinary Laboratory Service (2020) *All-Island Animal Disease Surveillance Report 2019.*

[58] Fernández, M., Ferreras, M., Giráldez, F., Benavides, J. and Pérez, V. (2020) *Production Significance of Bovine Respiratory Disease Lesions in Slaughtered Beef Cattle* in Animals, Vol. 10, Issue 10.

[59] Blakeborough-Hall, C., McMeniman, J. and González, L. (2020) *An evaluation of the economic effects of Bovine Respiratory Disease on animal performance, carcass traits and economic outcomes in feedlot cattle* in Journal of Animal Science, Vol. 98, Issue 2. Range is for sub-clinical to clinical disease diagnoses, respectively. Euro values converted by author from Australian Dollars using 2020 mean monthly average exchange rate, i.e. 0.6043. Morbidity incidence rate was c. 18%, while mortality incidence rate was c. 2.1%, in the sample.

[60] European Commission (2001) *The Welfare of Cattle kept for Beef Production.*

[61] Earley, B. and McGee, M (2016) *Managing Weaning* in *Teagasc Beef Manual, Chapter 46, pp.261-263.*

[62] AFBSI and DAFM VLS (2020) *All-Island Animal Disease Surveillance Report 2019*, pp.53-55.

2.5kg lighter and 27 days older at slaughter, with reduced feed conversion ratios and quality of meat[63]. Emissions were estimated to be 130% higher in suckler cows with BVD; 10% for those with liver fluke; and 4% for those with pneumonia, when compared to a healthy reference animal[64]. Preventing such illnesses is estimated in the Teagasc MACC to, on average, save costs of €46 per tonne of CO2e abated, indicating significant private benefits to illness prevention and animal health in general.

3. Overview of Beef Environmental Efficiency Programmes

3.1 Overview and Objectives

The Beef Environmental Efficiency Pilot of 2019 built on previous schemes aimed at improving environmental and economic efficiency in suckler cows. Under BEEP and BEEP-S, the weighing of suckler dam and calf pairs has been the mandatory action required for participation. Supplementary optional actions were introduced as part of BEEP-S.

Weight data are centralised and verified in the NHD maintained by the Irish Cattle Breeding Federation (ICBF). The ICBF is a non-profit organisation charged with providing cattle breeding information to the Irish beef and dairy industries to benefit farmers, the agri-food industry and, ultimately, the public by providing accurate data on genetic information that can be used to improve the national herd. Their objectives, in addition to maintaining the database which reduces the costs for DAFM in having to maintain it, include creating scientific knowledge to identify superior animals for breeding which can then inform farm management and industry-related decisions.[65] A Data Processing Agreement is in place between DAFM and the ICBF to govern the exchange of data which is derived from EU Regulation 1305/2013. Ireland is viewed as a leader in providing reliable data through this system by the international coordinating body ICAR,[66] given the cooperative nature of scientists, farmers, the State, and companies working together to maintain this information source. This has proven more difficult in other countries that do not have access to such a centralised system.

The objectives of the Beef Environmental Efficiency Programme include the following:

- Enhance the National Herd Dataset (NHD) for genetic evaluations to inform decision-making at farm level by identifying the most efficient suckler cows;
- Target the weaning efficiency of suckler cows and calves through the collection of the live weights of cows and progeny in the herd of each participant; and
- Improve the welfare of suckler calves, particularly at the time of weaning.

[63] Skuce, PJ et al (2015) *Livestock Health and Greenhouse Gas Emissions*, Scotland: Climate X-Change. P.55.

[64] Ibid. These estimates informed the Teagasc MACC, p.61.

[65] ICBF (2021) *About us*

[66] ICAR (2018) *List of Organisations with Certificate of Quality*

The pilot and subsequent BEEP-S iterations have had the common objective of generating data on the weight of cow and calf pairs, which can be analysed to evaluate weaning efficiency. The BEEP-S programmes added enhanced payments and conditionality to promote best practices around animal health. Vaccination, meal-feeding at weaning, and faecal egg testing were introduced as optional measures, with additional payments available for completing them. These actions were respectively targeted at reduced illness, improved weaning welfare and reduced liver fluke in sucklers.

3.2 Eligibility and Payment Rates

In order to participate in BEEP-S, farmers had to meet the following criteria:

- Over 18 years of age;
- Holds a valid herd number, with herd owner status;
- Possesses registered beef-breed animals; and
- Submitted a valid Basic Payment Scheme application in the scheme year

The backward-looking reference period was important as a safeguard against incentivising higher animal numbers. The reference birth period for admissible calves was 01st July to 30th June in both 2018/19 and 2019/20. Farmers must re-apply each year. Payments are calculated on the basis of costs incurred and income forgone excluding any economic gains.

A progressive payment structure was introduced for the 2020/21 BEEP-S schemes with a view to increasing uptake among relatively smaller farms, based on participant data from the pilot scheme in 2019. Below, the structure of payments in the pilot is compared to the 2020 and 2021 BEEP-S schemes. This shows the increased payments and conditionality in latter scheme designs relative to the pilot, as well as payment capping. A linear cut to payments can be applied by the Minister in the event of over-subscription to the scheme.

Action	*BEEP 2019*	*BEEP-S 2020 and 2021*
Action 1 *(Mandatory)* – Weighing	€40 per cow/calf pair weighed	€50 for first 10 cow/calf pairs weighed - €40 thereafter to a maximum of 100 pairs.
Action 2 *(Optional)* – Can select one of the following:	N/A	Meal Feeding at €30 per weighed calf, to a maximum of 100 calves, **or:** Vaccination at €30 per weighed calf, to a maximum of 100 calves.
Action 3 *(Optional)* – Can be selected in addition to Action 1 and/or ONE of the measures in Action 2.	N/A	Faecal Egg Testing at €10 per weighed cow, to a maximum of 100 cows.

Table Seven: Mandatory and Optional Actions available under BEEP 2019 Pilot and BEEP-S 2020 & 2021

Documentation of proof of compliance with the mandatory and/or optional actions was required to be held by participants and provided to DAFM officials on request for the duration of the programme[67]. Presentation of receipts, on request, was deemed sufficient proof of vaccination. Payments were made in compliance with EU State Aid rules under Commission Regulation EC1408/2013, under which total de minimus aid granted to a single undertaking cannot exceed €15,000 over any period of three fiscal years.

4. Findings

Given that there have been only two iterations of BEEP(-S) to date, ability to deduce trends from the available data is limited. We can, however, provide an overview of the existing data and examine the preliminary trends. These data are compared to examine whether BEEP(-S) is contributing toward achieving intended impacts in relation to its objectives.

4.1 Scheme Inputs and Processes

Eligible farmers could apply to participate in BEEP-S up to 15/05/2020 and could submit evidence of compliance from 01st January – 01st November 2020. Records and proof of actions undertaken had to be held – for instance, meal feed purchase, weaning date, vaccination purchase and date of administration. Joint herd numbers or partnerships required a paper authorisation to be completed. Optional actions which participants listed as their intention to complete, but later failed to, generated a penalty. Below, the requirements of participants are outlined for each of the BEEP-S actions.

Feature Box One: Compliance Requirements for each Action under BEEP-S 2020

Action One: Weighing of Animals

Weights of un-weaned calves and their dam had to be:

- Submitted within seven days to the ICBF;
- Measured on the same day and holding; and
- Calculated using registered scales

Action Two:

Participants could choose to do one of two optional actions, in support of animal welfare to reduce the incidence of pneumonia in calves and weanlings, through the method most appropriate to the individual holding.

(A): Meal Feeding pre- and post-Weaning

[67] The Terms and Conditions of participation in BEEP-S 2020 stated: "*The applicant must maintain a record to demonstrate the completion of the actions chosen for the Programme; The applicant must retain all receipts, documentation and other evidence to prove compliance with the programme action for the duration of participation in the programme; The record must be made available on request for inspection and administrative checks by the Department*"

Participants had to introduce meal feeding for a period of four weeks pre-weaning and two weeks post-weaning to reduce stress on calves at weaning time.

Or

(B) Vaccination

Participants had to conduct a vaccination programme against respiratory disease(s) in suckler cows. Veterinary advice had to be sought in advance to find a suitable programme.

Action Three: Faecal Egg Testing

Cows had to be placed in a clean pen. Participants collected at least ten faecal samples from at least ten fresh faecal deposits. The samples had to be placed in a zip-lock bag and submitted by post to an approved laboratory on the day of or day after sampling. The samples were checked for liver and rumen fluke.

Under actions one and three, participants received analysis of the results submitted to ICBF and/or DAFM. As a result of access to these analyses, participants could then make informed on-farm decisions; for instance, with the DAFM laboratory results of the faecal egg testing, cows could be dosed appropriately. Under the mandatory action of weighing cow/calf pairs, participants received a detailed evaluation of the efficiency of each animal – i.e. a weaning performance report (see Figure Ten) – which can inform breeding decisions.

HerdPlus® Profit through Science
Phone

Weaning Performance Report
Animals born between 01/01/2018 - 31/03/2018

ICBF.com

Print Date:
Herd Owner:
Herd Number:

B. Cow & Sire Performance

All Cows

	Calved in Period	No. Weighed*	Avg. Weight (kg)	Calf 200 Day Weight (% of Cow Weight)	
				Your Herd	Target
All	16	16	702	43%	42%
1st Calvers	6	6	631	42%	42%
2nd Calvers	3	3	655	50%	42%
3rd + Calvers	7	7	783	41%	42%

Figure Ten: Excerpt of a weaning performance report sent to a client from the ICBF.

This data can inform decision-making and breeding strategies by identifying clear trends which can be acted upon in a timely manner; for example, in the above, second-calvers have significantly higher efficiency compared to third calvers, so the producer may consider replacing their stock after the second calving, for instance. The weaning performance report provides the following comprehensive performance information to each participant[68]:

- Summary data of calf performance relative to a 200-day weight target of 250KG for females and 300KG for males

68 A full anonymised weaning performance report is included in Appendix B.

    - The top and bottom five male and female calves by adjusted[69] weight
- Summary data of cow/sire performance relative to weaning efficiency target of 42%
    - Overall cow/sire average performance
    - Performance by groups of first-, second- and third-or-more calvers
    - Top and bottom five cows based on weaning efficiency
    - Sires ranked by 200-day average weight of progeny
- Detailed summary of performance for each cow/calf pair
    - Weight, 200-day adjusted weight and weaning efficiency
    - €uro Star Replacement Index value

Separately, faecal egg test samples were sent to one of seven participating national laboratories who were able to facilitate the processing of samples. Results were returned to participants, and appropriate measures could then be taken if a test result was positive to ensure containment and timely animal health management.

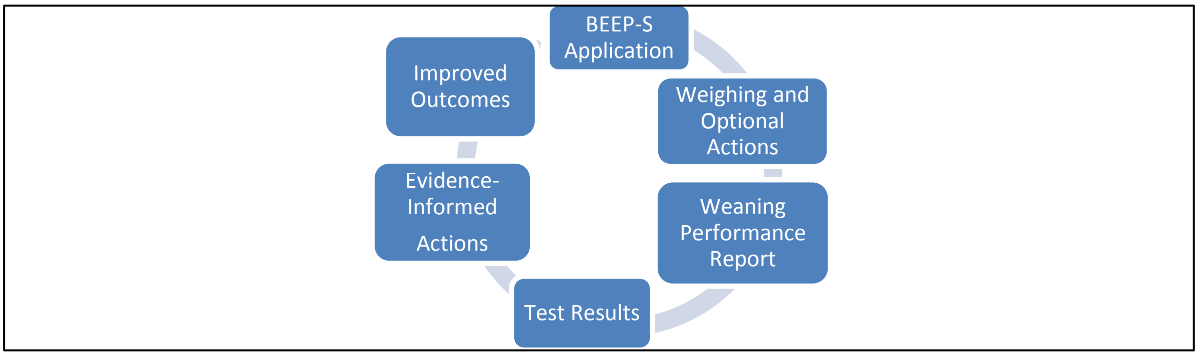


Figure Eleven: Process of Participation in BEEP-S – from application, to reports, to actions and outcomes.

<u>Weighing Scales</u>

Initial estimates in advance of the 2019 pilot projected c. 1,000 sets of scales were in private ownership within the sector, although it is unclear how prevalent the sharing of scales between farms was. While the provision of rental scales was addressed in partnership with ICBF, the number of scales in private ownership was a useful barometer of the acceptance of the practice and can inform future schemes. By the end of 2019, 4,438 sets of privately owned scales were registered with the ICBF for use by BEEP-S participants, or an increase of almost 340%, indicating producers may intend to continue with the practice.

Circa 30,700 weighing sessions were undertaken as part of BEEP-S 2020, equivalent to 1.13 sessions per applicant, indicating most participants were able to weigh all animals in one session. Approx. 6,100 weighing sessions (20%) were undertaken using scales registered and owned by participant farmers in 2020, while borrowing of scales was the most popular option for sourcing scales at 45% of all sessions undertaken. 5,166 weighing sessions were undertaken using scales used ten or more times, indicating the use of the services of a

[69] Data is standardised to adjust for age, giving a common metric which can be compared across cows.

Private Weighing Technician enrolled in the scheme. This is equivalent to 17% of all weighing sessions, or 38% of sessions completed using scales classed as 'borrowed'.

Source of Scales	Number of Weighing Sessions	Percentage Share of Weighing Sessions
Scales Registered to Another Farmer (Borrowed)	13,681	45
Scales Loaned from the Co-Op (Rented)	9,364	30
Scales Registered to Farmer (Owned)	6,099	20
Weighing Undertaken by ICBF Technician	1,564	5
Total	*30,708*	*100*

Table Eight: Summary of Weighing Sessions undertaken as part of BEEP-S in 2020 by source of scales.

Funding Allocation and Use

Total	BEEP	BEEP-S	Change (No.)	Change (%)
Participants	18,670	27,287	8,617	46.2
Total Animals	459,282	613,958	154,676	34.1
Mean Animals per Herd	24.6	22.5	-2.1	-8.5
Amount Paid to Participants (€m)	15.432	41.077	25.65	166.2

Table Nine: Summary of Participation, Herd Size and Funding in BEEP 2019 Pilot and BEEP-S 2020

The total number of participants and animals captured by the 2019 pilot and 2020 BEEP-S are compared in the table above. The 2019 pilot resulted in the recording of weights for c. 459,000 animals, with 18,670 participant farms receiving payments totalling approx. €15.43m. This represents a 97.4% success rate given 19,160 applications, and a mean payment of approx. €33.60 per animal[70]. The number of participant herds grew to nearly 27,300 in BEEP-S, with a net increase of 46.2% (8,617) in the number of herds which participated in the scheme. Given the additional drawdown of c. €25.65m for BEEP-S compared to the pilot, the additional actions carried out and the front loading of payments, payment levels under BEEP-S were higher on average. The total funding received by participants under the scheme in 2020 was €41.077m, of which €22.7m of this was paid out for weighing cow/calf pairs, which compares to €15.432m for the 2019 pilot.

Based on €22.7m paid out for weighing animals under BEEP-S, or c. €7.27m (47%) additional funding for weighing compared to the pilot scheme, the cost per animal weighed rose €3.37 (10%) to €36.97. The number of animals weighed rose 34%, relatively less than the amount of funding paid out for weighing, owing to the progressive payment structure implemented in 2020 to encourage uptake among relatively smaller farms. The additional funding paid per additional animal weighed was €46.99, or €13.39 (40%) higher than the average payment per animal weighed in 2019. The number of participants which weighed ten or fewer cow/calf pairs increased by 2,927 (87%), meanwhile, compared to a 38% increase among which weighed more than ten pairs. This indicates that the progressive payments were effective in encouraging uptake among this harder-to-reach and relatively inefficient cohort of farms in which there are significant opportunities for improved outcomes.

[70] Donnellan, T., Moran, B., Lennon, J. and Dillon, E. (2020) *Teagasc National Farm Survey 2019*, p.16..

4.2 Applications and Compliance

For BEEP-S, there was a 94.8% success rate for applicants in terms of receiving at least some funding, given 27,289 applications. Almost 98% of applicants opted for at least one of vaccination or meal feeding as additional measures under optional action A, with 86% of this group opting for meal feeding. This means almost one-in-eight (12.2%) selected vaccination at the application stage overall. Further, 73.5% opted for faecal egg testing under optional action B when applying. The main reasons for applications being at least partially unsuccessful were linked to non-compliance with optional measures. Faecal egg testing had the highest number of unsuccessful applications (4,432 or 21%), while meal feeding also had a relatively lower success rate (90%) when compared to weighing (95%) and vaccination (92%). Table Ten illustrates the breakdown of applications for the specific actions and their respective likelihood of success of application.

Option	Option Type	Total Applications	Successful Applications	Unsuccessful Applications	Success Rate of Application
Key		A	B	C	= (B/A)
Overall	Total (Weighing)	27,287	25,880	1,407	94.8%
Option A	Total	26,635	23,963	2,672	90.0%
	Of which Meal-Feeding	*23,389*	*20,970*	*2,419*	*89.7%*
	Of which Vaccination	*3,246*	*2,993*	*253*	*92.2%*
Option B	Total (Faecal Egg Testing)	20,970	16,538	4,432	78.9%

Table Ten: BEEP-S 2020 Number of Applications by Measure; and Application Success Rate by Measure.

Non-compliance with the mandatory weighing action, such as not submitting weights, resulted in participants receiving no payment for any of the actions – irrespective of compliance with the optional actions. 52.7% (31.7%) of unsuccessful applications for Option A (Option B) can therefore be accounted for by the 1,407 applicants who did not comply with the mandatory weighing action. There were also challenges for participants around the technical requirements of the optional actions – particularly faecal egg testing, where not submitting samples or samples not meeting laboratory requirements led to no payment for non-compliant participants. This meant a lower share of successful applicants received funding for optional actions compared to the share of applicants who chose these actions.

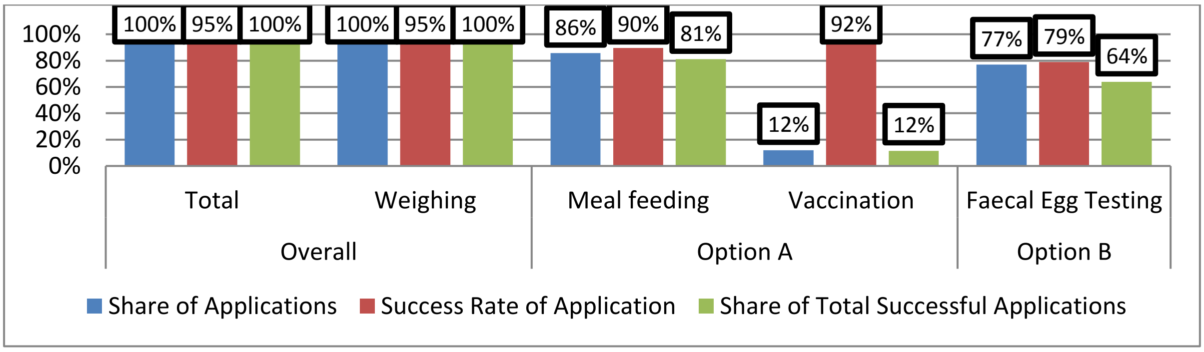


Figure Twelve: Share of BEEP-S Applications, Success Rate of Applications by Choice of Measure, and Measure Share of Overall Number of Successful BEEP-S Applications

While nearly 77% of all participants opted for faecal egg testing at the application stage, less than 64% of successful BEEP-S applicants overall were paid for completing this action. This reflects compliance challenges that meant the success rate for faecal egg testing applicants was only 79%. Faecal egg testing and vaccination only comprised 13.5% of total funding administered for actions, with weighing (55%) and meal feeding (31%) comprising the remainder of the €41.1m paid out to participants.

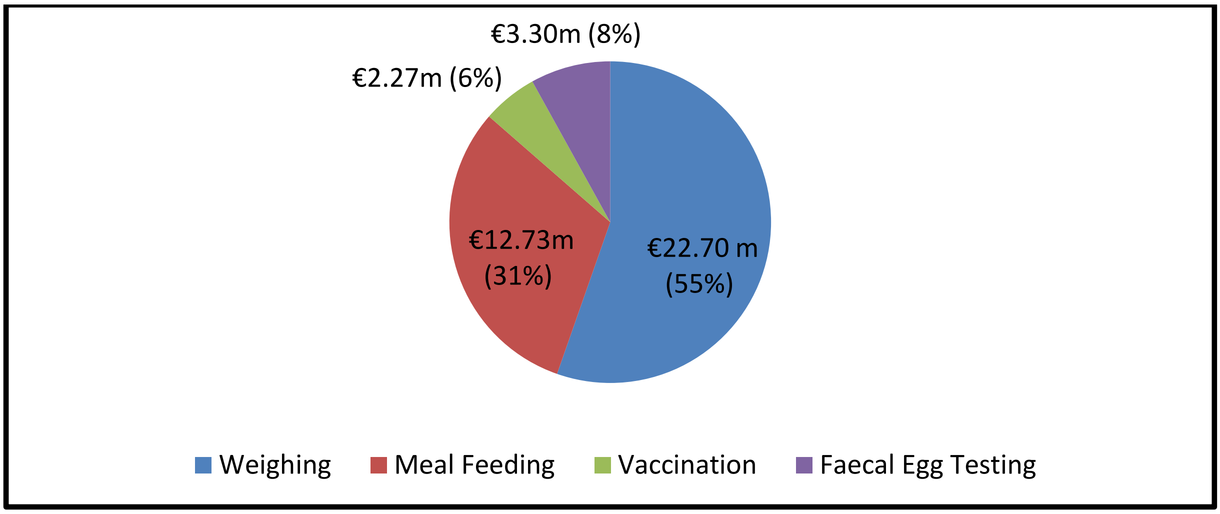


Figure Thirteen: Funding (Millions of Euro and Percentage Share of Overall Funding) for BEEP-S measures.

4.3 Participant Characteristics

Data from the Teagasc National Farm Survey shows that BEEP-S farmers tended to be younger, farmed larger areas, held higher numbers of stock and earned higher incomes than those who did not participate in BEEP-S.[71] The gap between these cohorts generally narrowed, however, in 2020 compared to the pilot. Selected descriptive statistics for 2019 and 2020 are provided in Tables Eleven and Twelve, respectively[72]:

Variable	BEEP-S Participant	Non-BEEP-S Participant	Ratio BEEP-S vs. Non-BEEP-S
Age of Farm Holder	55	63	0.88
UAA (Ha.)	36.6	27.5	1.33
LUs	44.9	30.0	1.50
GO/ha (€)	1,409	1,112	1.27
DP/ha (€)	562	406	1.39
FFI/ha (€)	352	162	2.17

Table Eleven: 2019 Summary of NFS Data on BEEP-S participants compared to other Cattle Rearing Farms

[71] Summary statistics provided by Teagasc upon request to provide a descriptive overview of selected data for farmers participating in BEEP-S versus non-participants. However, this data should not be inferred as a reflection on the performance of BEEP-S as there are a myriad of factors that drive farm performance.

[72] *Notes: UAA = Utilisable Agricultural Area; LU's = Total Livestock Units; GO/ha = Gross Output per hectare; DP/ha = Direct Payments per hectare; FFI/ha = Family Farm Income per hectare*

Variable	BEEP-S Participant	Non-BEEP-S Participant	Ratio BEEP-S vs. Non-BEEP-S
Age of Farm Holder	57	61	0.92
UAA (Ha.)	32.8	27.9	1.19
LUs	39.7	28.8	1.38
GO/ha	1,380	1,051	1.31
DP/ha	519	403	1.29
FFI/ha	332	188	1.76

Table Twelve: 2020 Summary of NFS Data on BEEP-S participants compared to other Cattle Rearing Farms

2020 BEEP-S participants had a high likelihood of also being participants in the BDGP and the BEEP pilot. Given participation in the BEEP pilot, a herd had an 87% likelihood of participating in BEEP-S, an 85% likelihood of participating in BDGP, as well as a 76% likelihood of participating in both BDGP and BEEP-S. This suggests farmers recognised the complimentary value of these schemes, as well as evidencing the financial significance of sector-specific schemes for farm households.

For general context Table Thirteen below shows the breakdown of the national suckler herd size profile in terms of herds with no milk supply contract on the 31st of December 2020. The table highlights that suckler farms are predominantly smaller farms, with 97% of herds holding less than 50 suckler cows. While 28% of herds have five or fewer animals, these herds represent only 5% of the population of animals; meanwhile, 21% of herds are of between 21 – 50 head in size but these herds hold 42% of the population of animals.

Herd size	Number of Herds	Percentage Share of Herds	Number of Animals	Percentage Share of Animals
=/< 5	15,770	28	45,123	5
6 - 10	11,582	21	91,883	11
11 - 20	14,831	27	222,119	27
21 - 50	11,514	21	347,575	42
51 - 80	1,443	3	88,068	11
81 - 100	210	0	18,631	2
101+	155	0	20,804	2

Table Thirteen: Summary of All Herds with No Milk Supply Contract at 31/12/2020, by herd size bracket. Source: DAFM AIM data.

An evaluation of the BEEP pilot showed a disproportionate number of larger herds availing of the measure, and as a result the frontloading of payments and a maximum ceiling were included in BEEP-S to encourage the participation of smaller herds. The rationale was to enhance equity in the distribution of the support by acknowledging the higher marginal transaction costs for smaller holdings. In order for the scheme to have the desired impact in terms of stimulating behavioural change in performance recording, the participant profile needed to reflect the herd profile as far as possible. Table Fourteen shows the profile of participating herds in BEEP-S, illustrating that the share of herds and animals in smaller size brackets remain below that of the general population.

Herd size	Number of Herds	Percentage Share of Herds	Number of Animals	Percentage Share of Animals
=/< 5	1,750	7	6,529	1
06 - 10	4,560	19	37,209	7
11 - 20	8,857	36	133,455	26
21 - 50	8,112	33	243,807	48
51 - 80	1,017	4	61,083	12
81 - 100	181	1	15,897	3
101+	89	0	9,701	2

Table Fourteen: Summary of 2020 BEEP-S herds by Herd Size Bracket. Source: DAFM AIM data

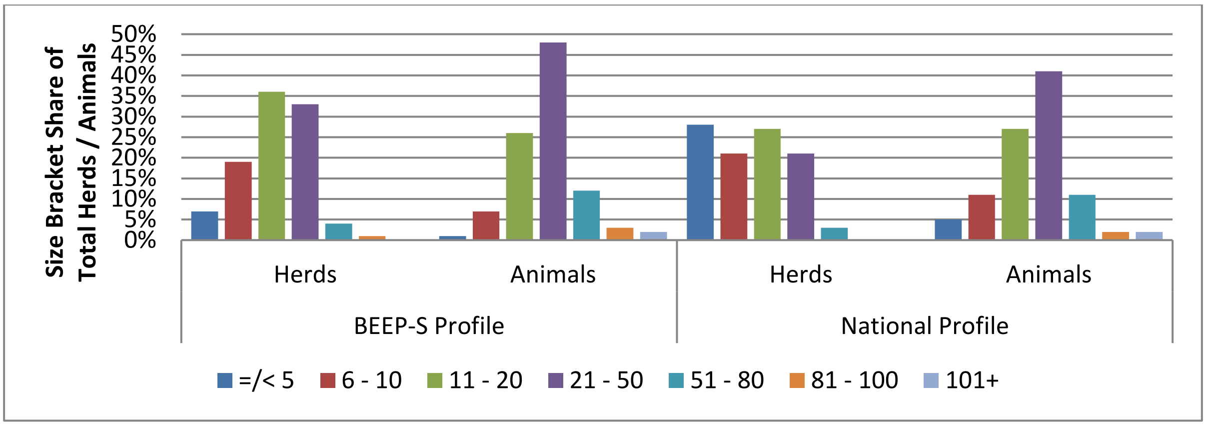


Figure Fourteen: Share of All Herds and Animals in size brackets of the number of animals per holding, for BEEP-S compared to the National Suckler Cow Herd on farms with no milk supply contract at 31/12 2020.

Looking at this information across the schemes provides a more nuanced interrogation of the interaction of these schemes, as illustrated in Table Fifteen.

Scheme	Mean Herd Size	Number of Participant Herds	Cross-Participation (%)	Total Number of Animals	Number of Animals as a Proportion (%) of Total Animals in BEEP-S
BDGP	22.2	24,396	N/A	541,591	88.2
BEEP	24.6	18,670	N/A	459,282	74.8
BEEP-S	22.5	27,287	N/A	613,958	100.0
BEEP and BEEP-S	25.5	16,167	87	412,259	67.1
BDGP and BEEP	27	15,913	85	429,651	70.0
BDGP, BEEP and BEEP-S	27.5	14,192	76	390,280	63.6
BEEP and BEEP-S, *but not BDGP*	20.4	6,623	35	135,109	22.0
BDGP and BEEP, *but not BEEP-S*	16	1,718	N/A	27,488	4.5
BEEP-S *but not BEEP*	17.4	8,280	N/A	144,072	23.5
BEEP *but not BEEP-S*	13.8	2,374	N/A	32,761	5.3

Table Fifteen: Summary of participant herds and animals in schemes and the level (%) of cross-participation.

BEEP and BEEP-S herd sizes are compared in the table above, illustrating the relatively smaller herd size in BEEP-S compared to the pilot. Payment frontloading of 25% for the mandatory weighing measure in BEEP-S 2020 increased uptake among relatively smaller farms in terms of herd size, particularly those who weighed 10 pairs or fewer, with a net 8,377 additional farms (+46%) participating compared to the pilot overall. Farms of fewer than 50 head represented all additional farms, and only 19% of participants had more than 30 head. While the proportion of farms of ten or fewer head remains below the comparable figure for the total population of beef farms, the number of herds of 10 head or fewer increased by 87% in BEEP-S compared to the 2019 pilot, whereas herds of greater than 10 head increased by only 38%. This indicates that BEEP-S was effective in attracting relatively smaller farms but that especially small farms face distinct barriers to entry. Such barriers could be linked to the higher age profile and off-farm employment rates in the sector, which could increase the opportunity cost of participation in the scheme for those with smaller holdings.

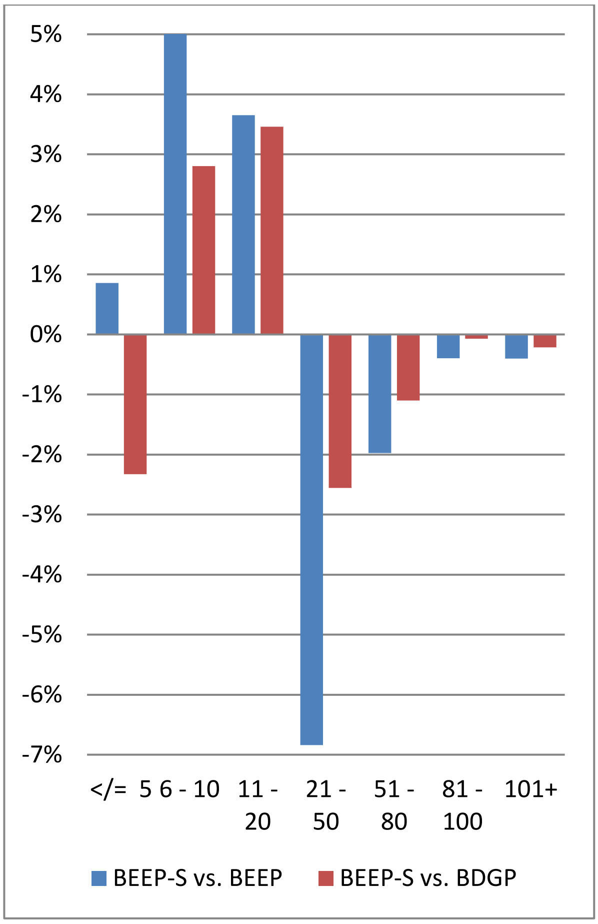
The increase in participation in BEEP-S relative to the pilot was driven by farms with a relatively smaller herd size (< 20). For BEEP-S herds, the number of animals weighed per participating herd was more skewed toward the lower end of the distribution when compared to the BEEP pilot or BDGP; 55% of BEEP-S herds had between six and twenty animals weighed, compared to 45% for herds which participated in the 2019 pilot. In 2019, 3,383 of 16,595 herds (20%) were paid on 10 of fewer pairs; this rose by 2,927 (87%) to 6,310 (26%) of 24,566 herds in 2020. The number of herds which weighed ten or more pairs was only 38% higher in 2020 compared to 2019, but represented 63% of the net change in total number of herds paid for weights.

Herds	Year	< 10 pairs Weighed	> 10 pairs Weighed	Total Paid on Weights
No. of Herds	2019	3,383	13,212	16,595
	2020	6,310	18,256	24,566
Share of Total	2019	20%	80%	100%
	2020	26%	74%	100%
Change (No.)	2020 vs. 2019	2,927	5,044	7,971
Change (%)	2020 vs. 2019	87%	38%	48%

Table Sixteen: Summary of herds paid for weighing, by herd size of greater or less than ten head in 2019/20.

The graph below evidences the skewed distribution among BEEP-S participants toward smaller size brackets (herds of 20 or less head) in general, when compared to the BEEP pilot or BDGP. This likely reflects payment front-loading in the design of BEEP-S, although the number of relatively smaller farms remained below the overall national level. The cumulative percentage of herds below herd size thresholds is also shown in the table below.

This implies BEEP-S is more closely aligned to BDGP than BEEP 2019 in terms of distribution, indicating complementarity. Previous research has shown relatively smaller farms, particularly within cattle farming, are slower to adopt new technologies; however, there are significant opportunities to increase efficiency within this group[73]. Encouraging uptake of measures such as those in BEEP-S is therefore valuable, indicating a significant impact for the national herd by targeting smaller farms[74].



Herd Size	BDGP	BEEP	BEEP-S
< 6	9.5	6.3	7.1
< 11	25.2	19.7	25.7
< 21	57.8	52.1	61.7
< 51	93.4	92.0	94.8
< 81	98.6	98.1	98.9
< 101	99.4	99.2	99.6

Figure Fifteen: *Left-Hand Side:* Percentage Point Difference in Share of Herds across Herd Size Brackets for BEEP-S compared to BEEP Pilot and BDGP. *Right-Hand Side:* Cumulative Percentage Share of Total Population of Herds by Brackets of Herd Size for BEEP-S, BEEP Pilot and BDGP

Most notably, farms which participated in all three of these schemes tended to have larger herd sizes compared to those which a) participated in BEEP-S having not participated in the 2019 pilot, or b) did not participate in BEEP-S having participated in the pilot. Farms of smaller size participated in BEEP-S compared to the pilot.

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[73] Howard, K. And Cawley, A. (2020) Spending Review of Teagasc Animal & Grassland Research and Innovation Programme, p34. DPER.

[74] CSO Farm Structure Survey 2016, Table 4.6, shows 38,200 (48.8%) of beef farms have < 20 Livestock Units.

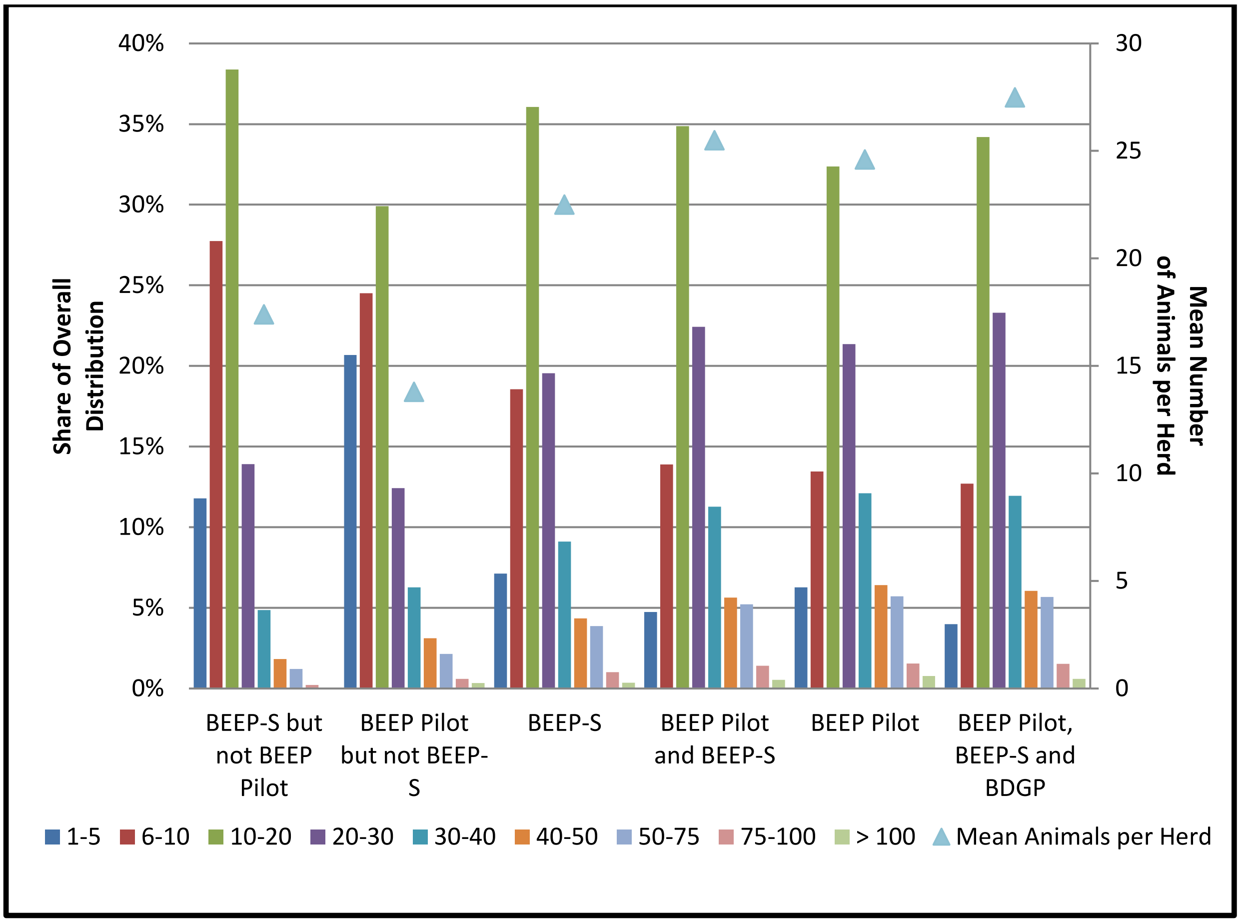

Figure Sixteen: *Left-Hand Axis:* Farms as a Share of Brackets of Number of Animals Weighed, by Participation Status, among BEEP Pilot 2019, BEEP-S 2020 and BDGP participant cohorts. *Right-Hand Axis:* Mean Average Number of Animals per Herd, by scheme participation cohort.

By comparing with the 2019 NFS data on Cattle Rearing farms, it seems a reasonable assumption that farms that participated in BEEP-S which held lower levels of stock were also of smaller farm size in terms of hectares, as indicated by the comparison in Figure Seventeen.

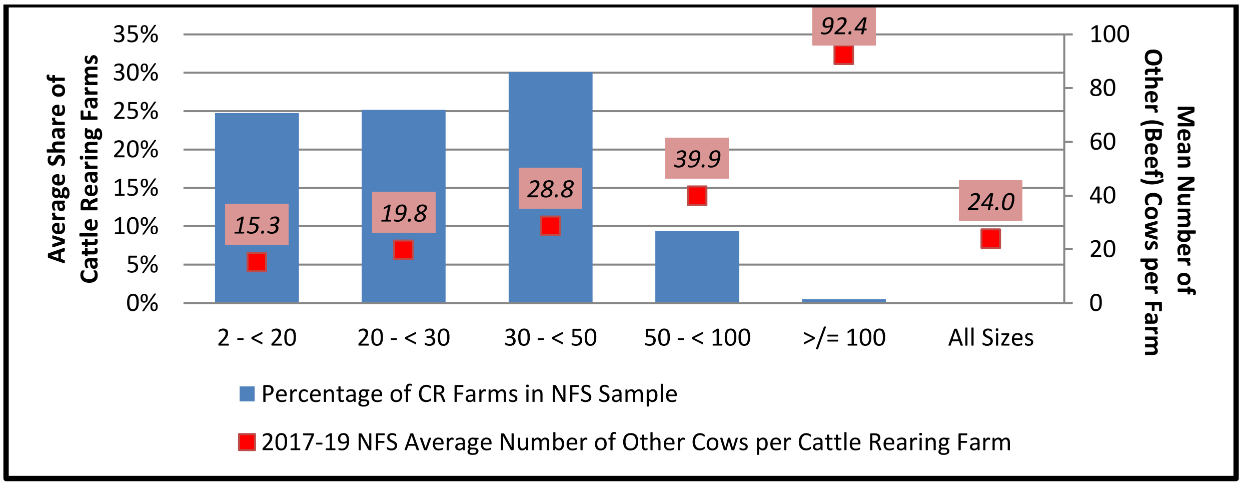

Figure Seventeen: Average Share of Cattle Rearing Farms in respective Land Size Brackets (Hectares) in Teagasc NFS 2017-19 [Left-Hand Y-Axis]; and Mean Number of Non-Dairy Cows per Cattle Rearing Farm, by Land Size bracket, in NFS 2017-19 [Right-Hand Y-Axis]. Source: Teagasc NFS Reports 2017-2019, Table 2

4.4 Herd Performance Data

In the tables below, analysis of BEEP-S data by the ICBF provides evidence of the efficiency gaps across star ratings and, in turn, the capacity for environmental and economic benefits from improving the genetic merit of the national herd[75]. Five-star calves are 103 days (17%) younger at slaughter, require 91 (23%) fewer days from weaning to slaughter, and their carcass weight is 40kg (11%) heavier than one-star calves. Five-star dams are, on average, 134kg (18%) lighter, have a €21 (26%) higher replacement index value, and their progeny have a weaning efficiency percentage 27 points (79%) higher than one-star dams. Average daily live-weight gain among five-star calves is also 55% higher than one-star calves. Overall, the cow/calf pair shows a 244 kg swing, with dams 134kg lighter and their calves 110kg heavier on average for five- versus one-star cows. The gaps are illustrated below.

€uro Star Rating	Dam Replacement Index Value	Dam 200-day Weight (KG)	200-day Calf Weight (KG)	Weaning Efficiency (%)
5	102	597	358	61
4	97	642	320	50
3	93	669	301	45
2	90	694	282	41
1	81	731	248	34
Difference 5 vs. 1 Star	+ 21	-134	+ 110	+ 27
% Difference 5 vs. 1 Star	+ 26	- 18	+ 44	+ 79

Table Seventeen: ICBF (2021) Analysis of weaning efficiency by star rating for BEEP-S animals.

€uro Star Rating	200-day Calf Average Daily Gain (ADG) (KG)	Calf Age at Slaughter (Days)	Days from Weaning to Slaughter	Carcass Weight (KG)
Five	1.57	509	311	392
Four	1.38	530	324	383
Three	1.28	551	342	375
Two	1.19	574	363	367
One	1.01	612	402	352
Difference 5 vs. 1 Star	+ 0.56	- 103	- 91	+ 40
% Difference 5 vs. 1 Star	+ 55	- 17	- 23	+ 11

Table Eighteen: ICBF (2021) Cow live-weight and efficiency performance by star rating for BEEP-S animals.

Change in Emissions Profile of National Suckler Cow Herd

Two key developments have resulted in an 11.2% (397 KT) reduction in estimated absolute emissions from the suckler beef herd per annum between 2015-2021:

[75] ICBF (2020) *Five Star Cows Delivering on Weaning Performance,* Tables 1-2.

a) Improvements in herd efficiency and composition – supported by the BDGP and BEEP-S – reflected in gains in the value of the replacement index; and
b) A 108,000 (10.6%) decline in suckler cow numbers, largely driven by cows in herds not enrolled in the BDGP (approx. 80% of the decline accrues to this cohort, which would disproportionately comprise of herds with a low number of suckler cows).

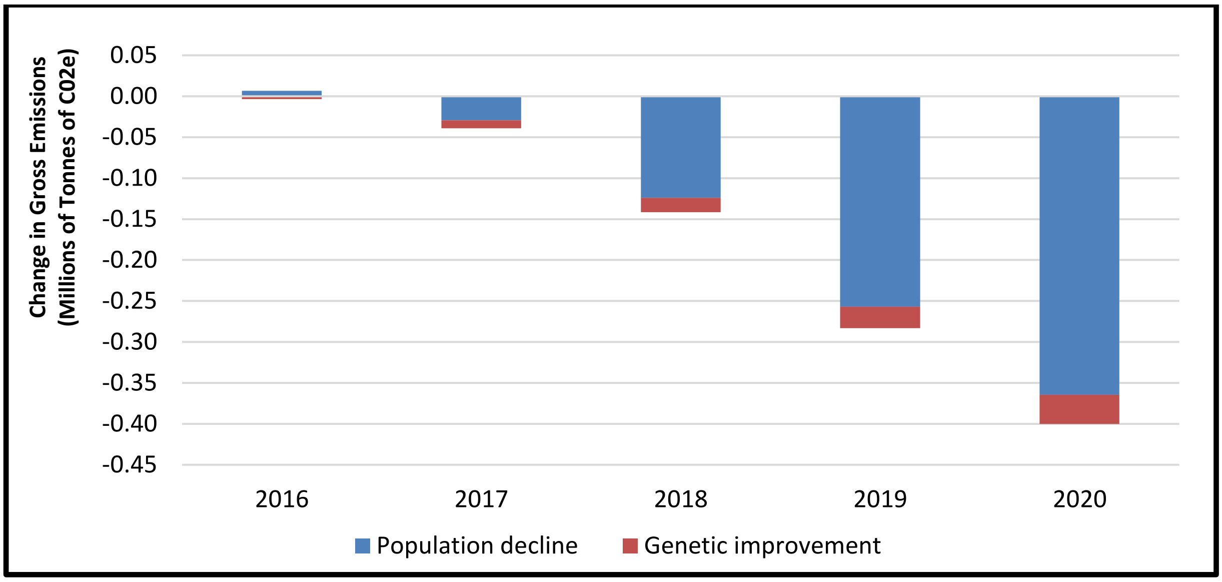

Figure Eighteen: Change in Emissions vs. 2015, by Source (decline in cow numbers and genetic merit gains). Genetic merit gains measured using Replacement Index value in Euro terms. Source: ICBF.

The estimated cumulative emissions saved since 2015 are equivalent to 1.2 MT CO2e within 2016-2021 – comparable to 34% (38%) of aggregate estimated 2015 (2021) suckler CO2e output, respectively. 6.7% of these accumulated savings accrue to efficiency gains from genetic merit improvements, secured through initiatives including BDGP and BEEP-S, while the remainder (93.3%) accrue to the decline in animal numbers. Emissions profile improvement is iterative, permanent, and cumulative as the genetic merit of the national herd progresses over time; this implies the impact of such efficiency gains will increase over time, as seen to date in the short period since 2015 in the chart above. Similarly, the proportion of the national herd covered by BDGP has increased from 49% to 54% since 2015, reflecting the fact that non-BDGP herds have represented 80% of the decline in cows.

Genetic merit can be measured using the Replacement Index and the Terminal Index. Each one Euro increase in the Replacement (Terminal) Index has been estimated to lead to a 0.81 KG (0.005 KG) decline in CO2e emitted per year per cow, reflecting the environmental and economic co-benefits of improved genetic merit[76]. For example, the substitution of lower-merit with higher-merit cows has led to a c. 45,000 increase in the number of cows of less than 30 months of age slaughtered within 2015-2020; while the number of calves per cow has increased from 0.85 to 0.87 per year in the same period. This translates to improved economic and environmental outcomes due to efficiency, as the distribution of cows becomes increasingly skewed towards what are, at present, cows at higher percentiles of the replacement index distribution, meaning high genetic merit cows become the norm.

[76] Quinton, C., Hely, F., Amer, P., Byrne, T. and Cromie, A. *Prediction of effects of beef selection indexes on GHG emissions* in Animal, Vol. 12, Issue 5, pp.889-897.

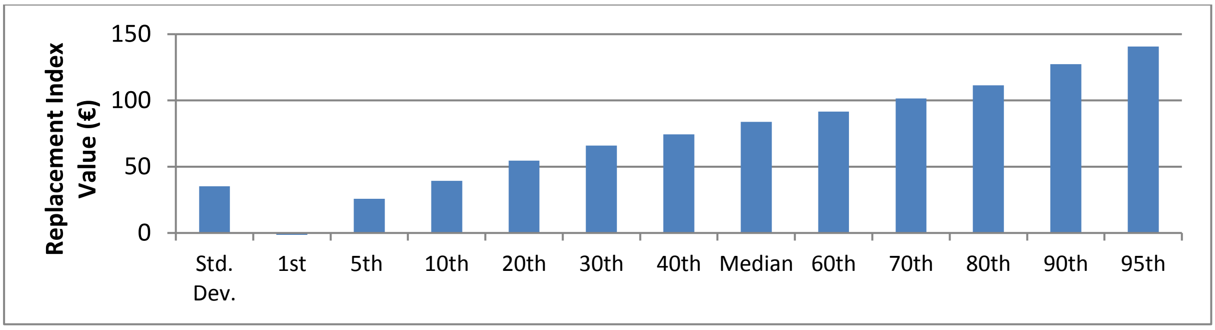

Figure Nineteen: Key Percentiles of Replacement Index Value for Sucklers in National Herd Database (NHD)

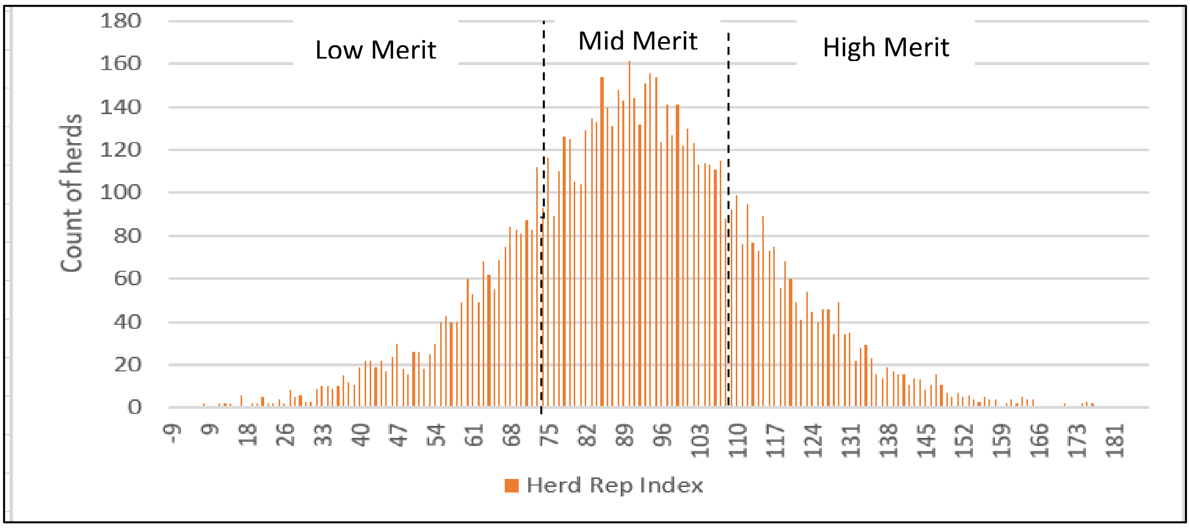

Figure Twenty: Representative Distribution of Herd Replacement Index Value. Source: ICBF

Estimated Emissions and Economic Savings from Maternal Genetic Merit Gains 2015-2021

Since 2015, the Replacement Index value per cow has increased cumulatively by nearly €23.26 (33%) per cow. This corresponds to a reduction of 37.68 KG CO2e output per cow per annum from improvements in maternal merit, and CO2e generated by the population per annum is estimated to be 34.2 KT CO2e lower in 2021 than it otherwise would have been with no change in the Replacement Index[77]. This rises to a saving of a cumulative 62.6 KT CO2e since 2015 from efficiency improvements alone – equivalent to c. 2% of the approx. 3.12 MT CO2e estimated to be emitted per annum at present – when compared to a scenario in which the Replacement Index mean value continued to decline at its 2009-13 average year-on year pace of -€0.57.

The economic value of the change in replacement index value since 2015, due to genetic merit improvements within 2016-21, is equivalent to a cumulative approx. €48.4m. This

[77] If cow numbers were the same in the counterfactual but there were no efficiency improvements, total emissions would have been 3.157 MT CO2e in 2021 – 0.342 MT CO2e higher compared to their estimated present level of 3.123 MT CO2e per annum. These estimates take into account realised changes in cow numbers, and assume a baseline of 3.475 T CO2e emitted per cow per annum at a population level. These estimates do not include changes in the Terminal Index, which generate a further 0.005 KG CO2e saving per cow per annum for each €1 increase in the Terminal Index.

includes abated GHG emissions shadow costs– €3.4m when valued at €32 per tonne of CO2e[78] – and the additional aggregate value (€45m) of more valuable cows in the national herd. This takes account of both the economic and environmental improvements achieved which can be directly estimated, however further benefits will have been secured which are challenging to value, such as improvements in technical efficiency. These improvements will continue as the data develops and supports breeding decisions going forward.

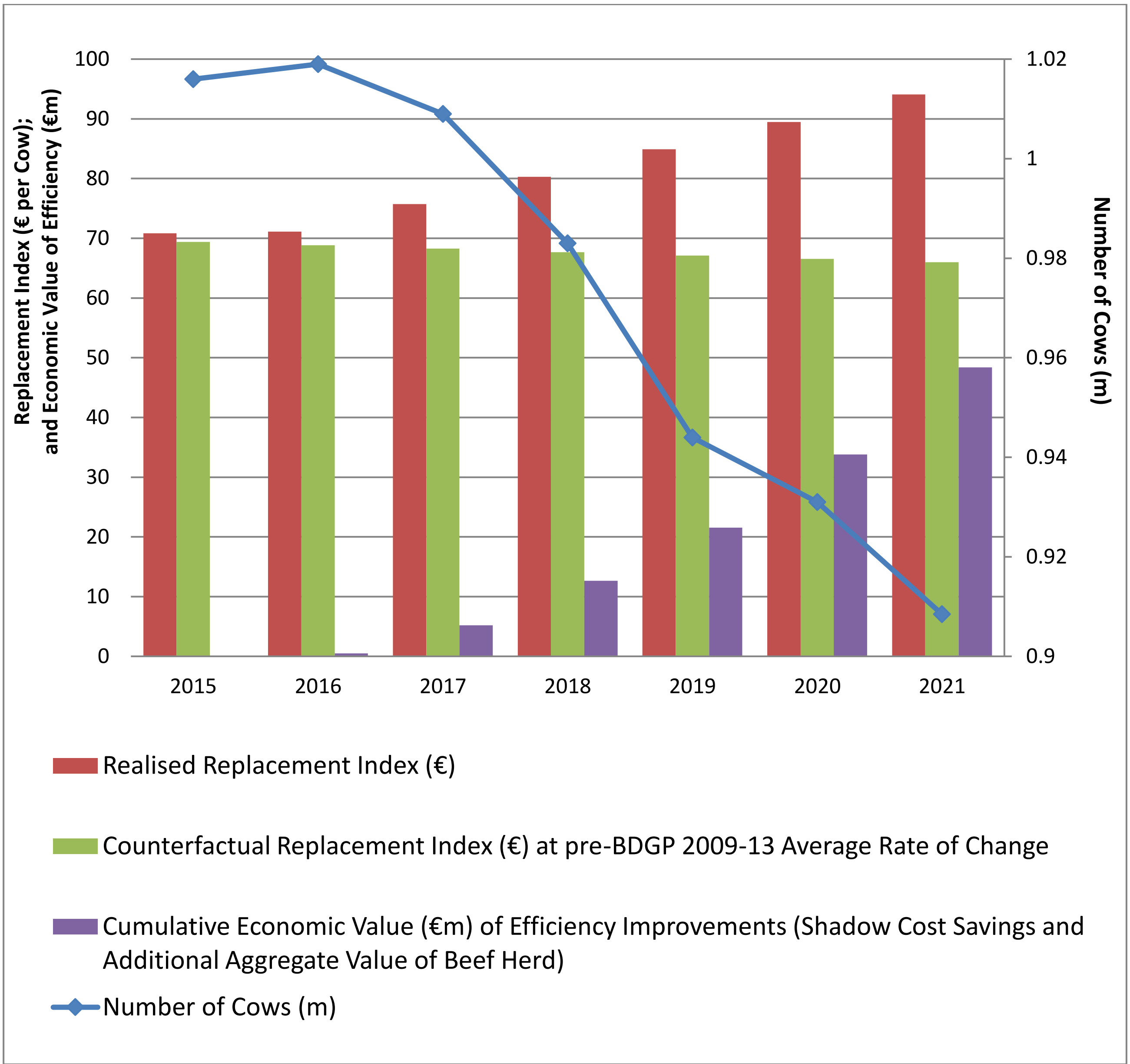

Figure Twenty-One: Trends in Mean Repalcement Index Value (realised vs. counterfactual of no BDGP) and Total Number of Suckler Cows (Millions) 2015-2021. Counterfactual sees continuation of 2009-2013 average year-on-year rate of change in Replacement Index value at -€0.57 per annum.

[78] Shadow Costs place a value on the societal costs of GHG emissions over time. Emissions are valued here at the 2020 shadow value of non-ETS GHG emissions in the DPER 2020 Public Spending Code, or €32 per tonne of Carbon Equivalent Greenhouse Gases emitted.

Factor	Formula	Description	2015	2016	2017	2018	2019	2020	2021
A	Source: ICBF	Number of Cows (m)	1.016	1.019	1.009	0.983	0.944	0.931	0.908
B	Source: ICBF	Replacement Index (RI) (€)	70.8	71.1	75.7	80.3	84.9	89.5	94.1
C	Running Sum Total	Cumulative Gain in RI (€)	-	0.3	4.9	9.5	14.1	18.7	23.3
D	(C x 2) * (0.81)	Cumulative Emissions Efficiency Savings (KG CO_2e per cow per annum)	-	0.46	7.90	15.35	22.79	30.24	37.68
E	(A x D)	Cumulative Emissions Savings from Efficiency for all Cows (KT CO_2e per annum)	-	0.47	7.98	15.09	21.52	28.15	34.23
F	(E*1,000) / (3,475 KG CO_2e) * 1,000)	*Expressed in Cow Equivalents*	-	135	2,295	4,342	6,191	8,101	9,851
G	(E/H)	*Expressed as a Percentage (%) of National Herd GHG Output*	-	0.01%	0.23%	0.44%	0.66%	0.88%	1.10%
H	A*(3.475-(D/1,000))	National GHG output sucklers incl. Genetic Gain (MT CO_2e)	3.53	3.54	3.50	3.40	3.26	3.21	3.12
I	A*B	Value of National Herd by RI (€m)	72.0	72.5	76.4	78.9	80.1	83.3	85.5
J	(I - I 2015)	Change in Value of National Herd compared to 2015 (€m)	-	0.5	4.4	7.0	8.2	11.4	13.5
K	Running Sum Total	Cumulative Value of Replacement Index gains (€m)	-	0.5	4.9	11.9	20.1	31.4	45.0
L	[32 * (E * 1,000)] / 1,000,000	Shadow Value of Emissions Saved per annum @ €32 per T CO_2e (€m)	-	0.02	0.26	0.48	0.69	0.90	1.10
M	Running Sum Total	Cumulative Shadow Value of Emissions Saved	-	0.0	0.3	0.8	1.4	2.3	3.4
N	M+K	Total Economic Value of Emissions Savings from Efficiency and Cow Number Reductions	-	0.52	5.20	12.66	21.53	33.78	48.39

Table Nineteen: Summary of Unit and Aggregate Emissions Savings per Annum relative to 2015 baseline. Note: 3,475 KG (3.475 T) CO_2e emitted per cow, on average, at 2015 baseline. Each one Euro increase in the Replacement Index (RI) generates a 0.81 KG CO_2e saving per cow per annum, as per Quinton et al (2018).

Estimated Effect of Efficiency Mitigation Measures to 2030

As the above table illustrates, efficiency improvements compound over time as gains made in previous years accumulate. The iterative nature of these improvements means that a relatively long time horizon is required to achieve significant aggregate emissions savings. If current genetic trends continue, the ICBF project that beef sector GHG emissions output will be 2.1% (71.4 KT CO_2e) lower than the 2020 level for a constant given number of cows by 2030, or 5.4% (180.6 KT CO_2e) lower for a given level of beef produced, at 2030. This translates to 7.5KG less CO_2e emitted per cow per annum, or 18.9KG less CO_2e emitted per 175KG beef produced[79]. Securing further gains and accelerating the speed of progress will require an additional focus on feed intake composition and efficiency, including forage quality and diet supplementation, as well as specifically selecting for methane traits.

Two primary efficiency improvements can reduce the aggregate sector emissions profile:

a) Each one month reduction in slaughter age translates to removing c. 115 KT CO_2e, if they are not replaced with more animals (equivalent to approx. 21,000 cows); and
b) Each one month reduction in age at first calving translates to removing 32 KT CO_2e, if they are not replaced with more animals (equivalent to approx. 6,000 cows).

Taken together, these improvements in terminal and maternal traits are projected by the ICBF to have the potential to generate 7.3% and 2.1% savings at 2030 relative to the total emissions profile of the national suckler herd in 2020, or 9.4% together. There is significant variation in genetic traits at present, indicating capacity for improvement through efficiency gains over time. High genetic merit animals are currently slaughtering at 20kg heavier and 7 days younger, equivalent to approx. one month when carcass weight is controlled for; while there is an approx. one month gap between the top and bottom 10% of herds in terms of age at first calving. The current average age at slaughter is 26.4 and 28.2 months, respectively, for heifers (females) and steers (males); while the current average age at first calving is c. 31 months. Lowering these ages can deliver significant mitigation of emissions.

As inefficient animals are incrementally replaced, and as gains compound over time to produce cumulative positive effects for the emissions profile associated with the national beef herd, GHG emissions will reduce on an absolute basis if animal numbers remain stable. It is therefore important to acknowledge that the enduring structures put in place in recent years will provide long-term benefits into the future, and these gains will have a permanent positive impact on the emissions profile associated with the national herd.

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[79] The figure of 175kg is derived from Quinton, C., Hely, F., Amer, P., Byrne, T. and Cromie, A. *Prediction of effects of beef selection indexes on GHG emissions* in Animal, Vol. 12, Issue 5, pp.889-897.
175kg is the mean average beef output per suckler cow, estimated as the total beef output of the national herd divided by the number of suckler cows. This accounts for those cows which are exported, used as replacement heifers or who die prior to slaughter. The average gross output per suckler which is slaughtered is closer to 330 kg c.w.t., however the lower net figure is considered here.

The ICBF have projected gains in RI value, at current trends, estimating these maternal gains will produce a cumulative market economic value of sector output of €606m in present terms by 2030 when compared to value remaining constant at its 2020 level. There will be further economic benefits from Terminal Index gains which are not considered here. ICBF also estimate that implementing additional mitigation actions and placing a cap on beef output could enable up to 11.4% mitigation compared to 2020 emissions, by 2030, based on current rates of progress.

Isolated Impact of BEEP-S on Emissions Output

In terms of the isolated impact of BEEP-S on absolute emissions, an extended period of time needs to be considered to account for the cumulative, iterative and permanent savings which accrue from efficiency measures such as those in BEEP-S. Without BEEP-S, such savings would not materialise and are additional to existing savings projections. The average difference in Replacement Index (RI) reliability of a First-Calving heifer – before and after the cow/calf pair has been weighed – is estimated by the ICBF at 15%. At present, 55% of the RI is comprised of cow weight, milk and growth traits. As a result, when the 15% selection accuracy premium is weighted by 55%, an expected 8.25% increase in selection accuracy is expected due to BEEP-S. This can be estimated to hold a market value of €49.995m at 2030 when compared to a scenario in which the Replacement Index value per cow holds consistent at its present level, i.e. without BEEP-S.

The emissions impact of BEEP-S alone has been estimated by ICBF to result in a mitigation of 14.9 KT CO2e per annum at 2030. This figure is a cumulative total, building each year to reach 14.9 KT CO2e mitigation per annum at 2030, or an annualised equivalent of 1.49 KT CO2e mitigated with each additional year. At 2030, this would mean that emissions will be 0.5% lower than their 2020 level (i.e. 0.5% lower than they otherwise would be) due to BEEP-S. It can also be estimated that the shadow value of the 14.9 KT CO2e saved per annum due to increased selection accuracy from BEEP-S can reach €1.49m at 2030, when valued at €100 per tonne of CO2e, compared to a scenario without BEEP-S. This 14.9 KT CO2e emissions mitigation per annum at 2030 is supplementary to the baseline 71.4 KT CO2e mitigation which can be achieved through current measures. Coupled with the increased market value of superior cows in genetic terms of c. €50m from above, this means BEEP-S can generate a total economic value of nearly €51.5m at 2030, which would be accumulated and permanent. 3% of this economic value derives from shadow emission cost savings, while the remainder accrues to improved market outcomes due to improved genetic merit of stock. Additional gains which cannot be quantified will also arise from improvements due to BEEP-S, such as improvements in technical efficiency and culling, as well as improvements in animal welfare outcomes.

Further Opportunities

This review has highlighted the value and importance of the NHD, as it provides a strong evidence base which can inform both targeted policymaking and farm-level decisions in support of improved outcomes over time. While the dataset has advanced significantly with the inclusion of BEEP-S related data, there may be other metrics that could enrich the dataset further. For example, capturing data on feed-related metrics such as silage quality would enable further analysis to improve the existing feed quality and encourage further efficiency gains. Similarly, the level of crude protein used in meal could also be captured as a performance-related metric, with a view to optimising the level of use of crude protein in meal feed. This could be incorporated in future measures to support the environmental and economic sustainability of production.

5. Conclusion

Although a longer time frame is needed to fully evaluate the impact of the BEEP-S scheme, the preliminary data presented in this analysis highlights some key trends that are in line with longer term projections on the future performance of the beef sector. The BEEP-S scheme complements existing schemes, particularly the BDGP in that it addresses a data gap in appending performance related data to an evolving database of genetic based information. This complementarity is reflected in the high level of cross-scheme participation and the database provides the basis for improved farm-level management decisions that will lead to improved economic and environmental performance of these beef herds over time, which is in line to wider policy objectives for the sector.

Further gaps in the evidence base have been identified as part of this Spending Review – particularly around the crude protein content of feed as well as forage quality – which provide opportunities for improvements through actions in future schemes. For example, silage testing or compliance requirements related to the crude protein content of feed could generate further environmental and animal welfare benefits by supporting farmers to make informed farm and animal management decisions.

The number of farmers participating increased under BEEP-S and they tended to be marginally smaller on average which implies that the front-loading of payments has had a positive impact on the motivation to participate in the scheme for smaller herds. There has been a varied take-up rate in the voluntary measures, with the vaccination option significantly lower than the meal-feeding or faecal egg testing options. Compliance rates with scheme requirements have been encouraging and it will be critical to ensure that the data generated through these actions is actively used to inform on-farm decisions, particularly for breeding.

In terms of environmental performance BEEP-S is estimated to add an expected 8.25% to the selection accuracy of animals, which provides a strong evidence base to inform production decisions when added to the information already generated through genetic information. If current trends continue, and the structures and underpinning data continue to develop, longer-term iterative, cumulative and permanent benefits will be locked-in for the future beef herd in Ireland. Schemes such as BEEP-S are actively contributing and adding to these longer-term policy objectives and the sustainability of the sector.

Recommendations

Although the preliminary evidence is positive, there are a number of aspects that could be improved for future policies in this area.

- Continue to build the National Herd Dataset further and integrate this evidence base with other sustainability metrics – particularly in the areas of climate, animal health and welfare. This can, if such collated information is disseminated effectively, inform farm-level decisions, and improve aggregate environmental and economic outcomes.
- Incorporate the principles of BEEP-S alongside BDGP in an integrated approach, as both are complementary in improving the national beef herd through permanent cumulative gains. Performance data such as weights and weaning efficiency estimates can be used in conjunction with genetic information by farmers to inform production decisions.
- Improve the communication of the benefits of the vaccination option to ensure a greater level of uptake, and likewise to improve the compliance rate for faecal egg testing.
- Build on the evidence base established to date by incorporating silage quality metrics, and/or the optimum level of use of crude protein content in meal feed, to enhance these performance-based metrics further.

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)

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

- ☐ Other (relevant details)

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