Mike Coffey and Ross Evans

Ruminant Methane Mitigation Conference

Art of the possible by 2030 and beyond

#MethaneBFS23

Breeding cattle to produce less methane per kg product

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Ross Evans

We have already been doing it!

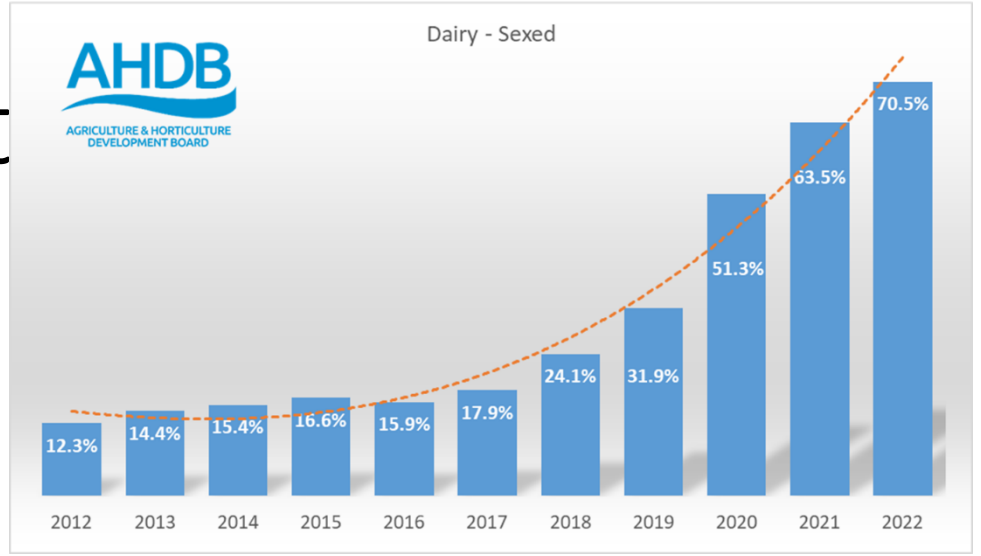
- Increased production per cow
- Improved disease resistance
- Increased fertility

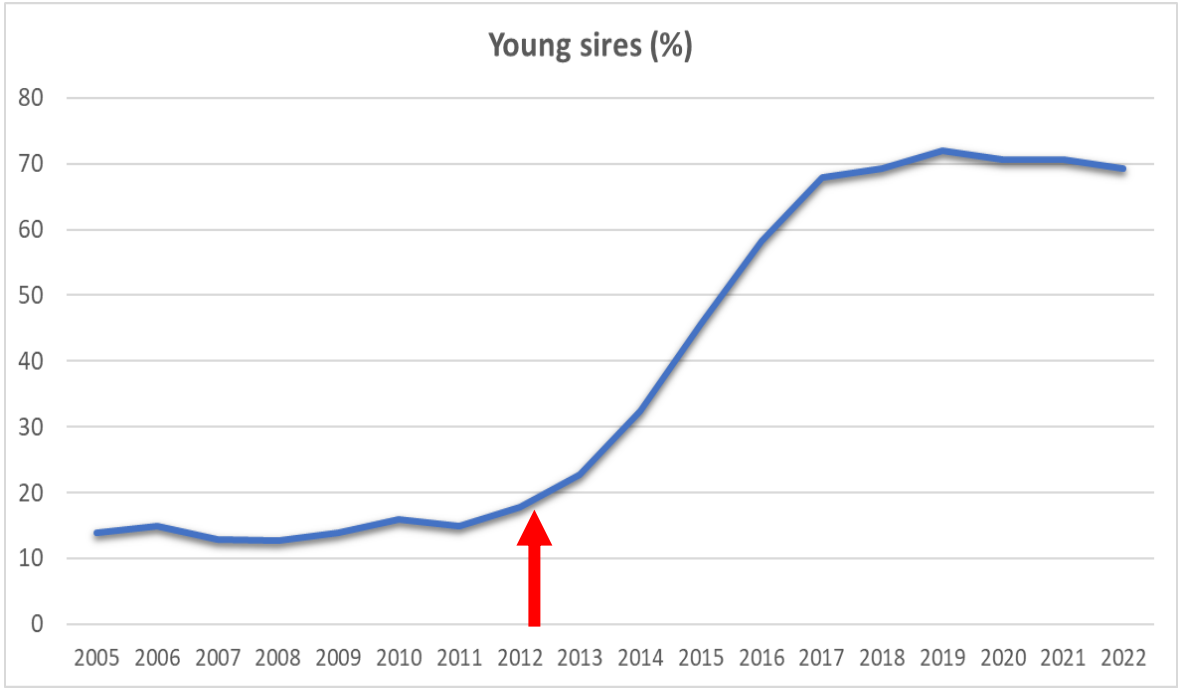
- Dilute fixed maintenance costs
  - Fewer cows to produce same product
- Reduced wastage of productive days
- Reduced wastage of infertile cows and fewer replacements
- More opportunities to select best cows
  - Sexed semen has helped

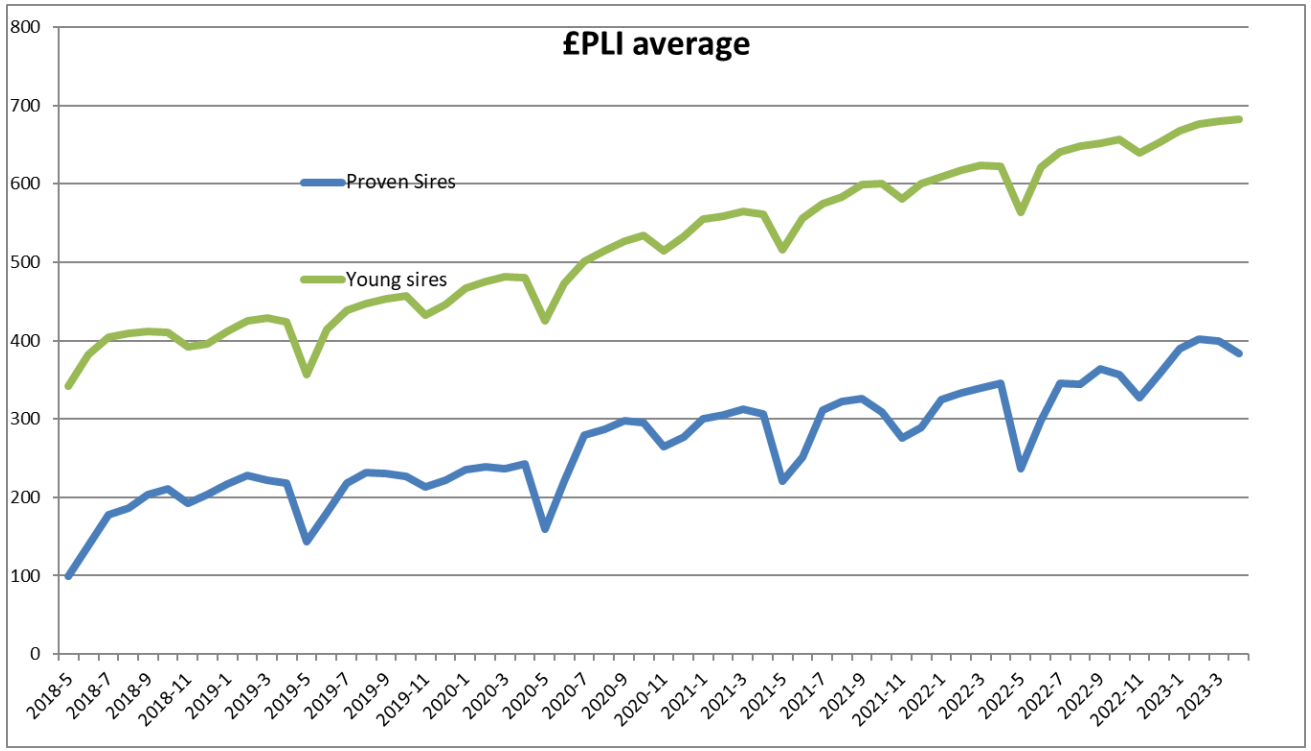
- Lower environmental cost

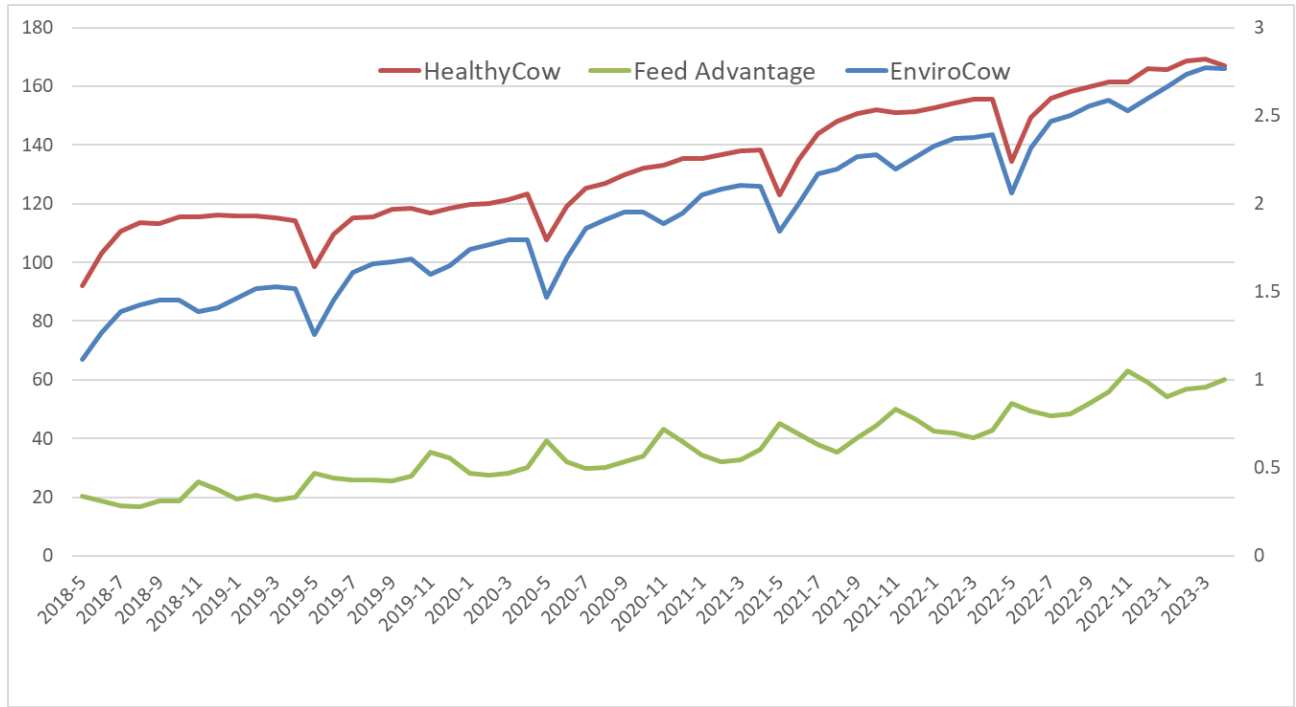
UK dairy breeding in a snapshot

- Use of sexed dairy ⬆
  - ✓now >70% of all dairy inseminations
- Use of beef semen ⬆
  - ✓Close to 50% of all inseminations
- Use of genomic young sires ⟺
  - ✓at ~70% of all dairy inseminations
    - ➢ (doubling genetic progress !)






£PLI average
800
700
600
500
400
300
200
100
0
Proven Sires
Young sires
2018-5
2018-7
2018-9
2018-11
2019-1
2019-3
2019-5
2019-7
2019-9
2019-11
2020-1
2020-3
2020-5
2020-7
2020-9
2020-11
2021-1
2021-3
2021-5
2021-7
2021-9
2021-11
2022-1
2022-3
2022-5
2022-7
2022-9
2022-11
2023-1
2023-3


HealthyCow
Feed Advantage
EnviroCow
180
160
140
120
100
80
60
40
20
0
3
2.5
2
1.5
1
0.5
0
2018-5
2018-7
2018-9
2018-11
2019-1
2019-3
2019-5
2019-7
2019-9
2019-11
2020-1
2020-3
2020-5
2020-7
2020-9
2020-11
2021-1
2021-3
2021-5
2021-7
2021-9
2021-11
2022-1
2022-3
2022-5
2022-7
2022-9
2022-11
2023-1
2023-3

BUT

- Things are not optimal
- Cows are getting bigger
- We need to reverse that trend

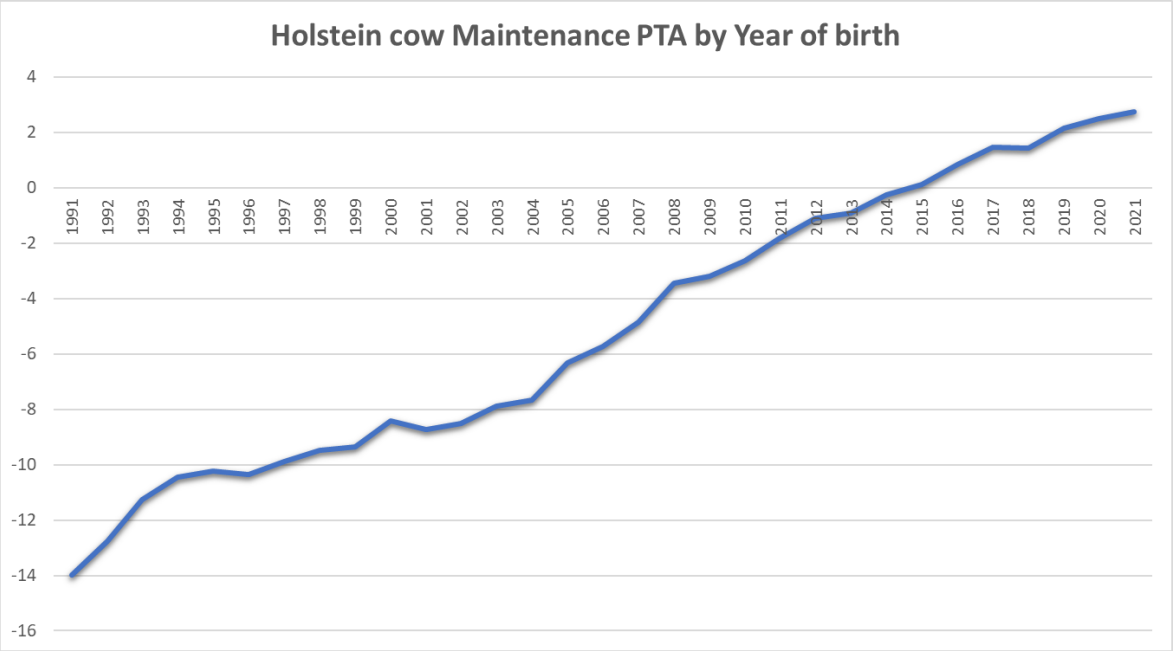
- Do more of what we have already done and doing it faster can reduce methane emissions NOW

- Recording methane emissions is required for longer term selection

- The important word is AND

Breeding has significantly changed today's cow

Unfavourable trend in Maintenance



- Bigger cows means we now have an equivalent of 60,000 tonnes of cow LW to feed each day in the UK !
  - Which is ~90,000 mature HOL cows

- For an average herd of 200 cows
  - Roughly 10 extra cows to feed

    …each day

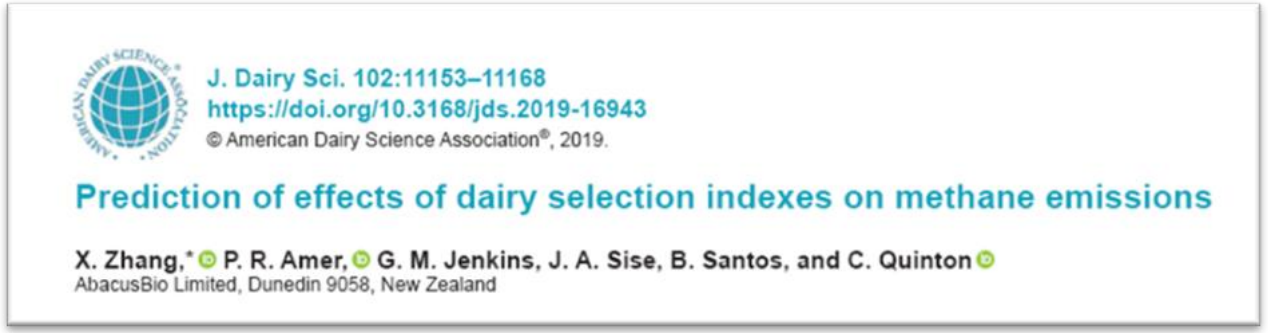
EnviroCow

- Genetic index to reduce CO_2 equivalent per kg product produced
  - Using Methane production as our target GHG

- Many of our indexes already contribute to improved efficiencies (!)
  - E.g. Yield per cow, improve health, improve lifespan, reduce feed

- We calculate Methane Intensity = Gross Emission per KG product (Kg Protein equivalent)
  - For every trait we can calculate additional contribution to both Emission and Product (‘*Trait Intensity*’)

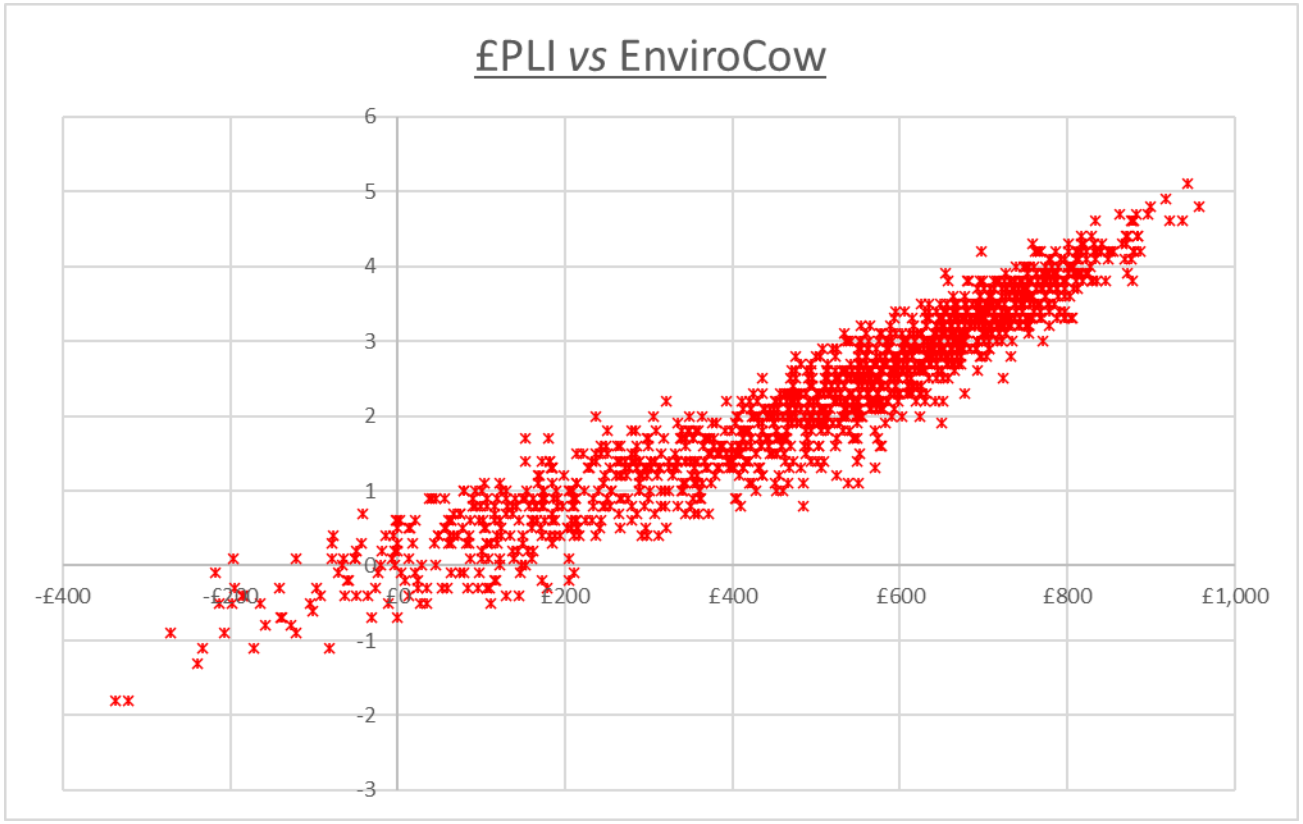
- Using the Mature cows output as;
  - Milk, Fat, Protein (per lactation)
  - Meat (cull cow – once in her lifetime)


J. Dairy Sci. 102:11153–11168
https://doi.org/10.3168/jds.2019-16943

Prediction of effects of dairy selection indexes on methane emissions

X. Zhang,* P. R. Amer, G. M. Jenkins, J. A. Sise, B. Santos, and C. Quinton
AbacusBio Limited, Dunedin 9058, New Zealand

Active Holstein bulls



EnviroCow	Count
6	1
5	60
4	343
3	403
2	305
1	211
0	67
-1	6
-2	0
-3	0
-4	0
-5	0

#bigcowsarebad

SRUC

- Increased maintenance costs (ongoing)
- Increased growing costs
- Increased lameness odds
- Increased DA odds

- Higher cull cow value
- Higher beef calf value

- Higher environmental cost

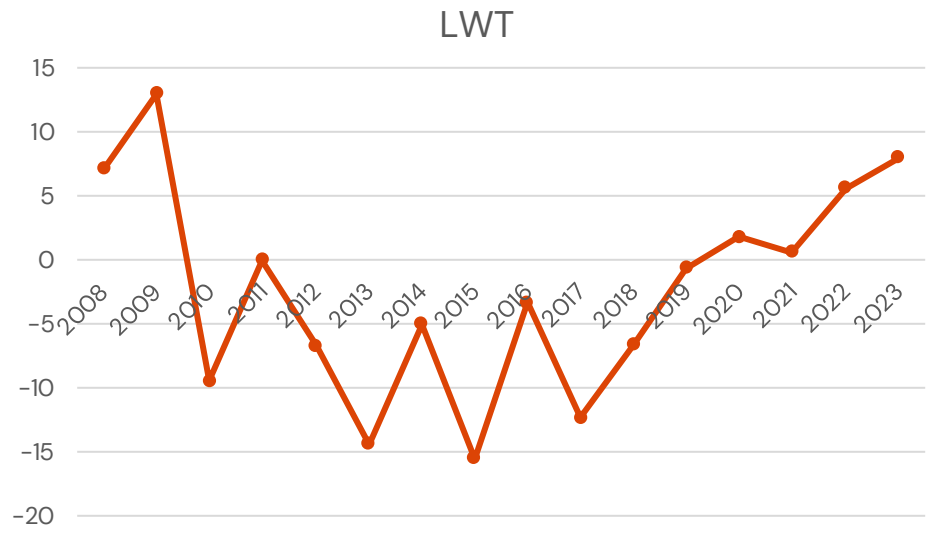
Fastbreeders

- Liveweight
  - Many weights across life and lactation(s)
  - gEBV is average across all weights (days)
  - Shows rising trend in recent years

- Simple model (similar to milk)
- Correcting for heterosis and recombination using milk recording pedigree

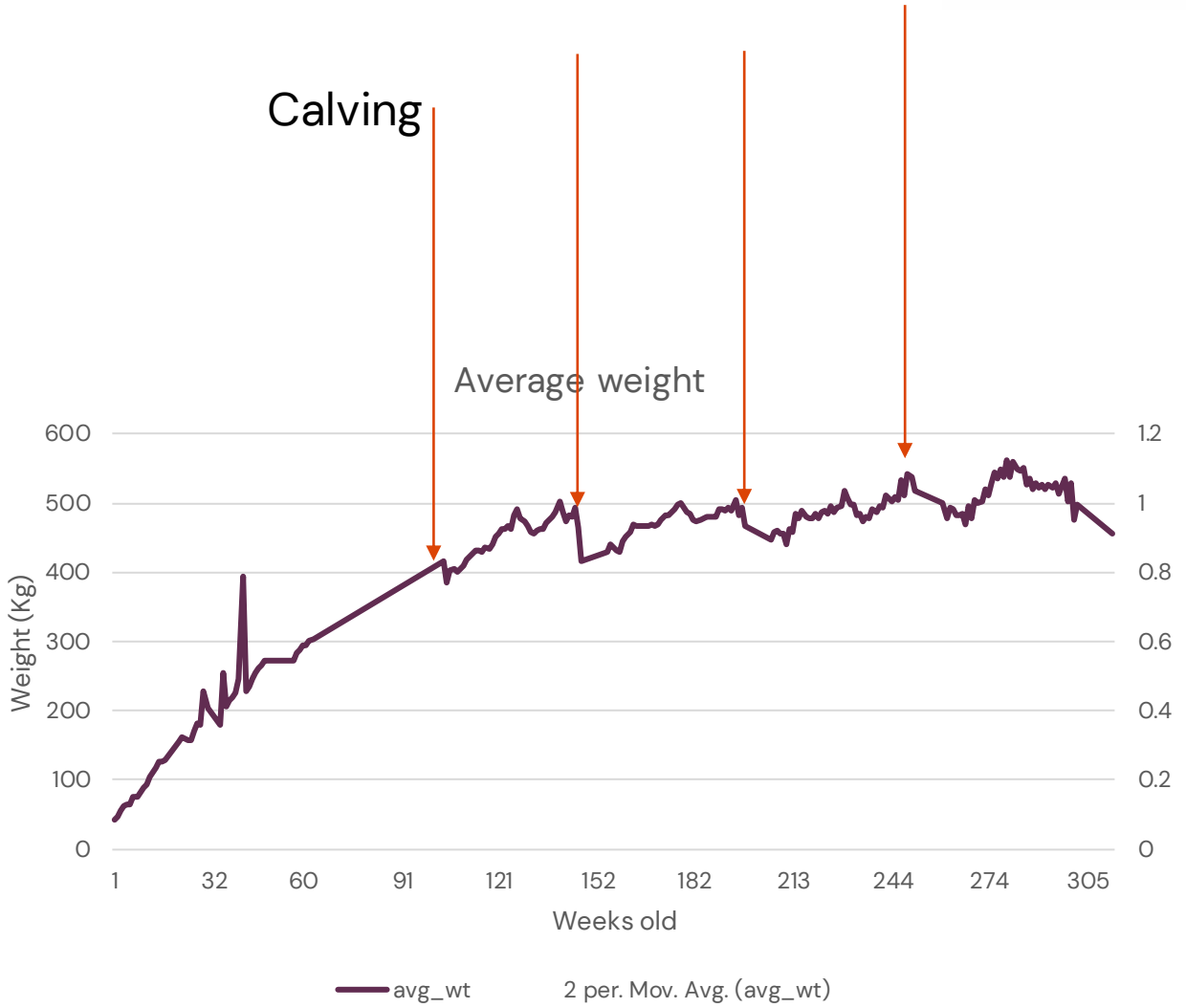
SRUC

  - Know its wrong and work is underway looking at admixture to use DNA to calculate genomic het/rec



Actual calf and cow weights from Fastbreeders herd

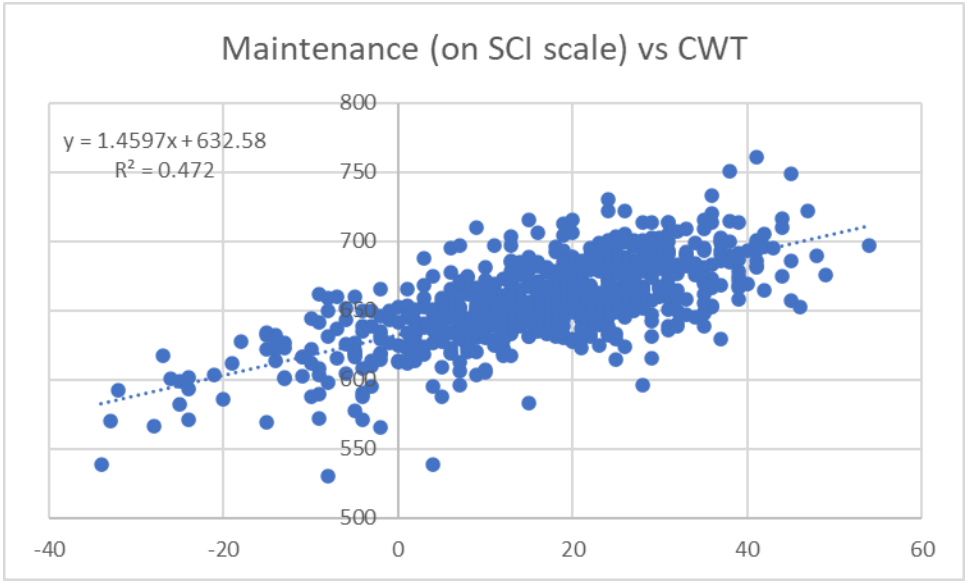
Weekly average from a walk over weigher weighing twice per day

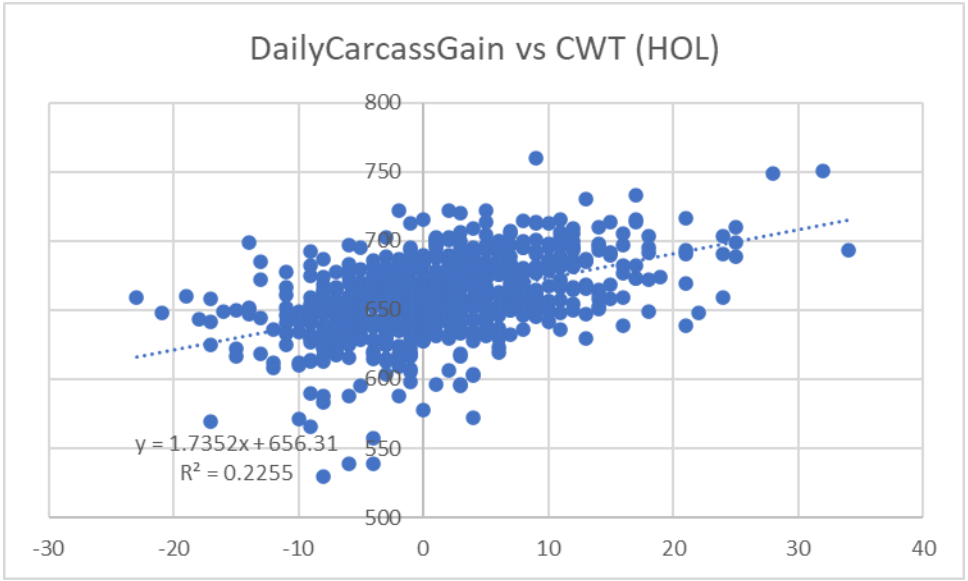


Cull Cow carcass weight as a proxy for liveweight

Top and bottom 10 sires ranked on average of dtrs cull weight (47% KO)

localsireid	avg_wt	recs
650000013888677211M	760.4	135
650000007072692911M	750.8	133
640000001127890811M	749.1	122
600000053674301911M	733.3	107
630000075589897211M	729.9	171
650000013282534211M	722.2	193
640000010804865911M	722.2	148
650000012227479811M	721.6	100
010000000066265311M	719.9	354
650000006999013811M	716.2	235
650000006998134911M	715.8	154
.....		
.....		
200000000060314911M	571	158
620000000009839011M	571	133
200000000058389411M	570.5	147
620000000009632911M	569.1	420
200000000063869511M	566.2	131
620000000010813811M	565.6	113
620000000010608311M	557.3	143
620000000010607911M	539	132
620000000010823511M	538.9	116
84377913	535.9	101
620000000010823711M	530.1	174





SRUC

Feed Advantage

- Feed intake highly correlated to methane output
- Using feed intake records from Langhill herd to create UK SNP key
- Applied to UK genotyped population
- Not ideal but we need to move early
- Records added each year
- Discussing with other partners about access to feed intake records
- Cant wait for perfection

Predictions from milk MIR

- Feed intake
- Methane
- Working with NMR and European groups to secure access to a methane prediction equation
- Currently looking at using fatty acids as a proxy
- Need to up our game on this one – climate crisis

In the end...

Im Zeitalter des Genotyps ist der Phänotyp König

#PHENOTYPE IS KING!

Genotyypin aikakaudella fenotyypi on kunigas

Genotyyppiaikakaudella fenotyyppi on kuningas

Fenotype blijft de koning

في عصر التركيب الجيني
البيانات المظهرية هي الملك

En la era del genotipo ...
¡El fenotipo es el rey!

Την εποχή του γονοτύπου, ο φαινότυπος είναι βασιλιάς!

فینوٹائپ بادشاہ ہے

Breeding for methane : the Irish perspective

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

AgTech - it's in our DNA

Setting the scene!

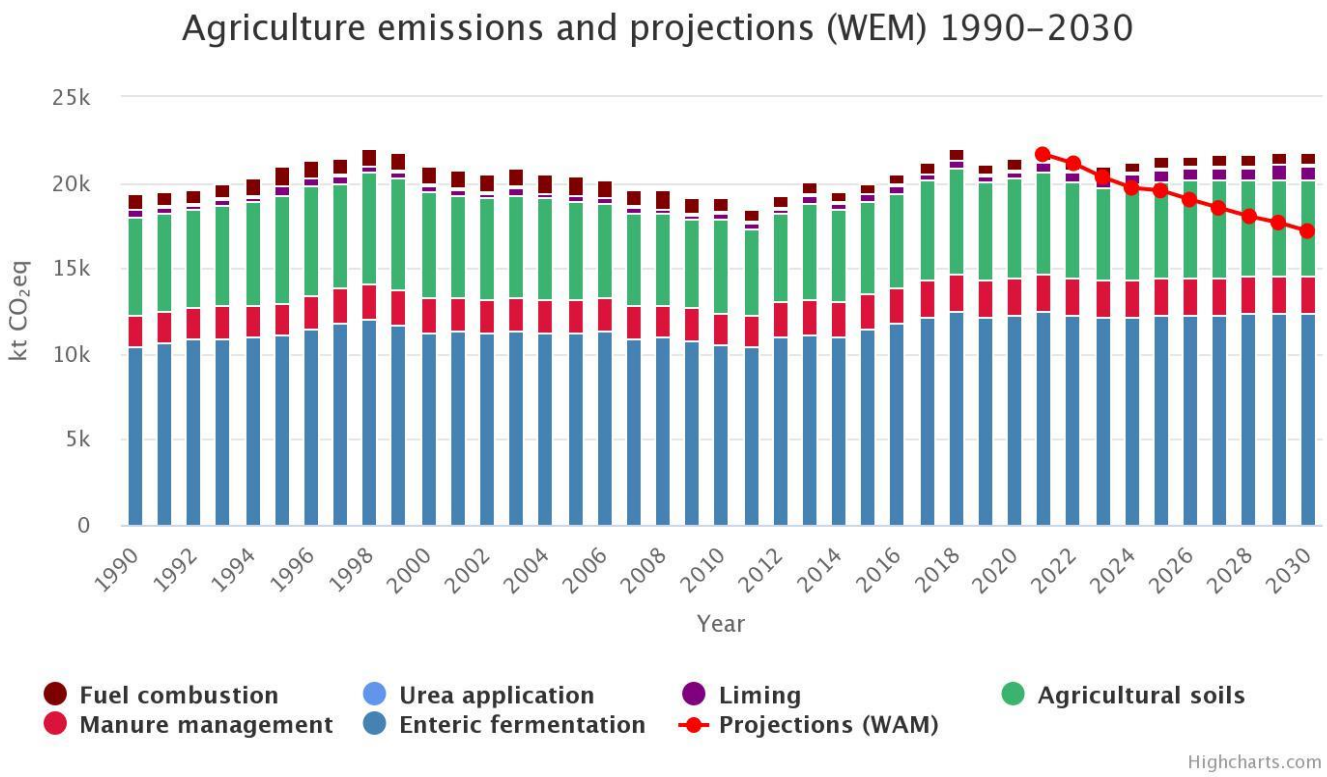
CLIMATE CHANGE, POLLUTION

Ireland to Cut Emissions from Agriculture by 25% by 2030

BY MARTINA IGINI | EUROPE | AUG 2ND 2022 | 2 MINS

EARTH.ORG IS POWERED BY OVER 150 CONTRIBUTING WRITERS

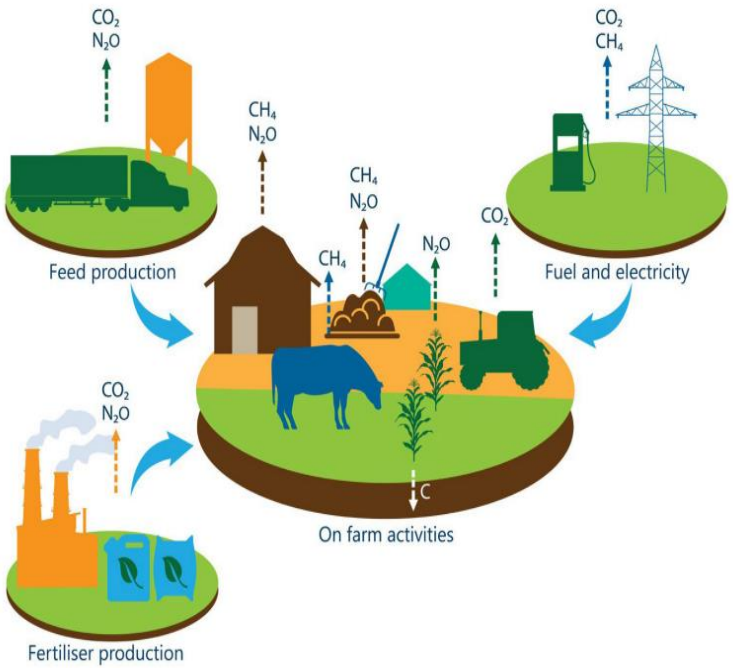
Following weeks of discussion, Ireland's coalition government passed a deal last week under which farmers will be asked to cut emissions from agriculture by 25% by the end of the decade, compared



- Given the generation interval in cattle in particular we must act now for breeding to have a meaningful impact by 2030

Genetic strategy for Carbon breeding

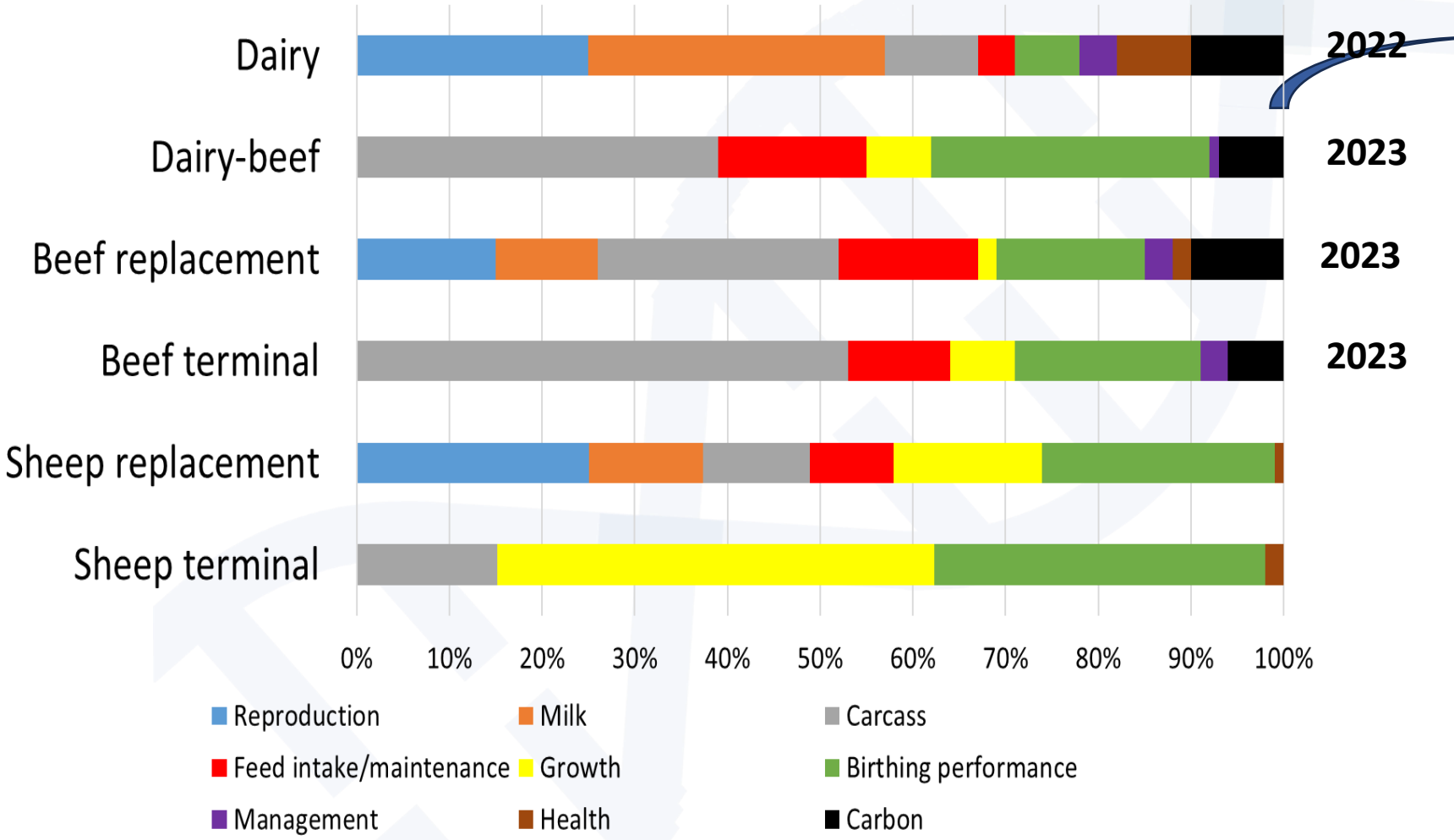
Bio-economic modelling and LCA integration



Carbon value for each genetic trait

Profit indexes

Deployment Framework



2022

2023

2023

2023

Future

Non-Enteric

Enteric (Methane ebvs)

Can we breed directly for lower methane?

Pre-requisites

Important

Measureable

Genetic control
Heritability + variation

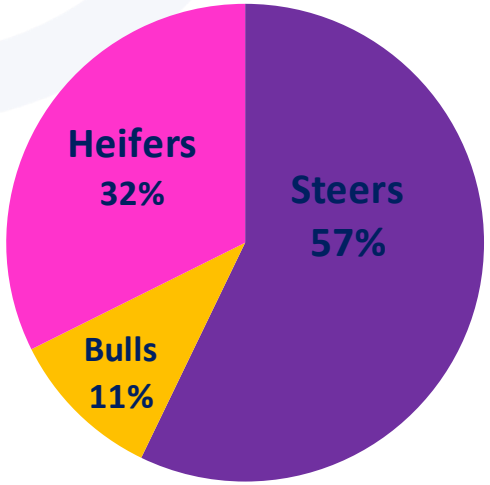
What does the literature say?

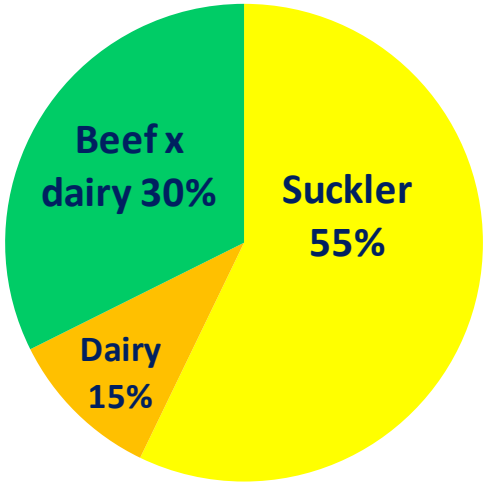
Authors	country	Animal type	breed	method	Locations	records	Measure time	Diet	Heritability
Robinson et al., 2010	Australia	Non lactating adult sheep	Multiple	Respiration chamber	1	708	1hr	Wheaten hay	0.13
Pinares-Patino et al., 2013	NZ	Growing sheep	Multiple	Respiration chamber	1	1,225	48 hr x 2	Grass pellet	0.29
Pickering et al., 2015	UK	Lactating cows	Holstein	Laser gun	1	57	15 min x 3	Mixed forage	0.05
Donoghue et al., 2016	Australia	Growing Heifers, Steers	Angus	Respiration chamber	1	1046	48 hr	Roughage	0.27
Lassen & Lovendahl, 2016	Denmark	Lactating cows	Holstein	SF6 Tracer	20	3,121	Full lactation	N/A	0.21
Van Engelen et al., 2018	Netherlands	Lactating cows	Holstein	Sniffer	11	1,508	Full lactation	N/A	0.11
Van Breukelen et al, 2022	Netherlands	Lactating cows	Holstein	Sniffer	14	1,746	Full lactation	N/A	0.13

- Very small datasets in cattle breeding terms…… very expensive phenotypes
- Range in heritability of 0.05 to 0.29. Low to moderate range….But better than fertility!

Phenotyping

- 40+ Greenfeeds in circulation in Ireland. Many IP constrained
- 9 in Tully progeny testing center ICBF operated
- Commercial crossbred progeny of AI sires
- ~2000 CH4 phenotypes since 2019
- All animals genotyped
- Feed intake using insentec machines
- 8,800 feed intake phenotypes since 1970s



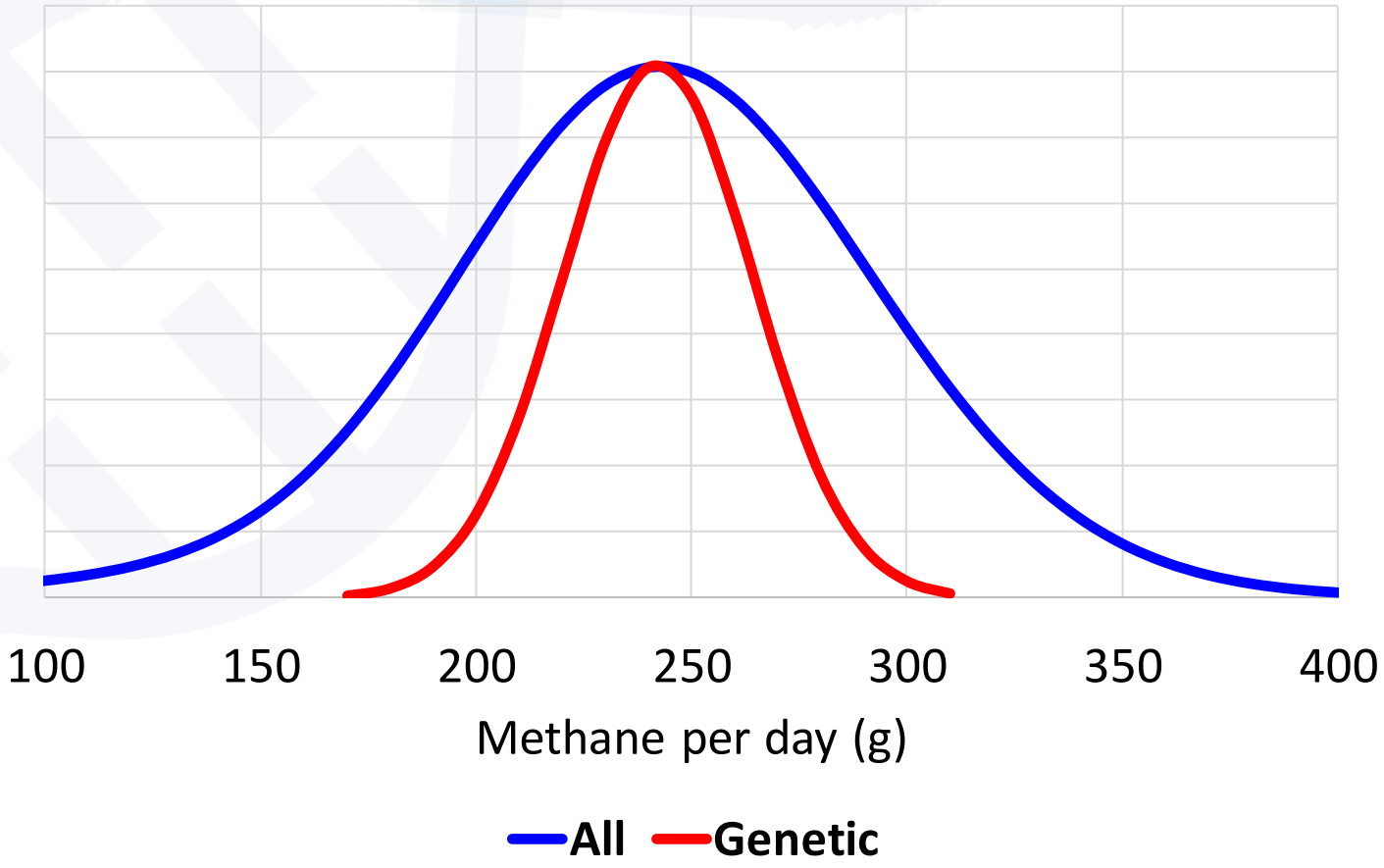


Department of Agriculture, Food and the Marine
An Roinn

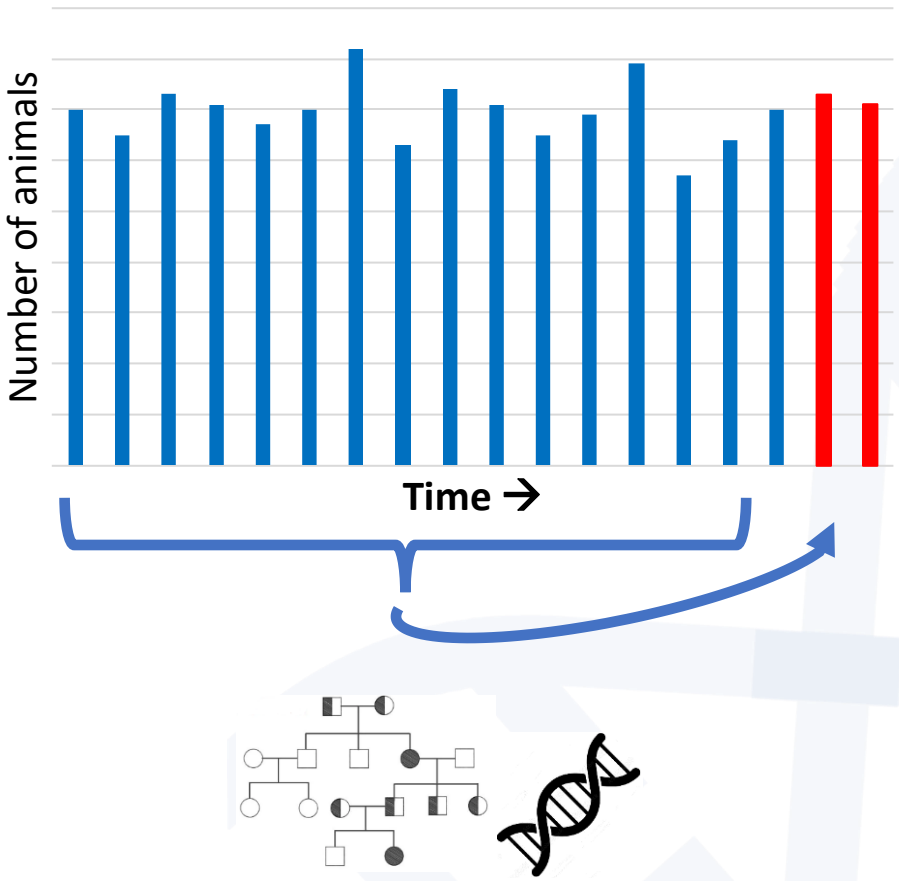
eagasc
Agriculture and Food Development Authority

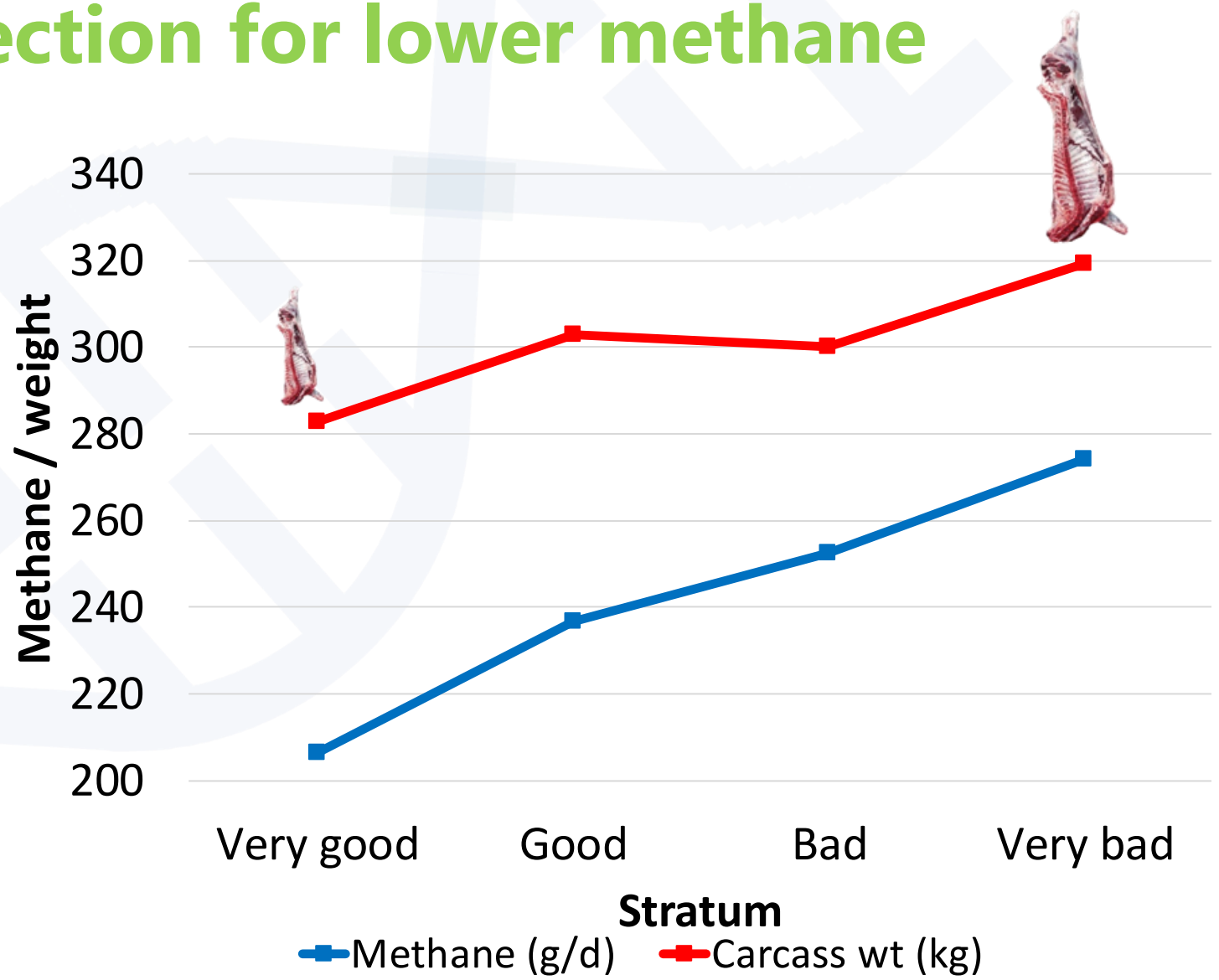
Prototype methane evaluation

	CH4 (g/day)	DMI (kg/day)
Animals	1,525	3,348
Observations	393k	274k
heritability	11%	25%
Genetic correlation	0.7	
Genotypes	8.7k	

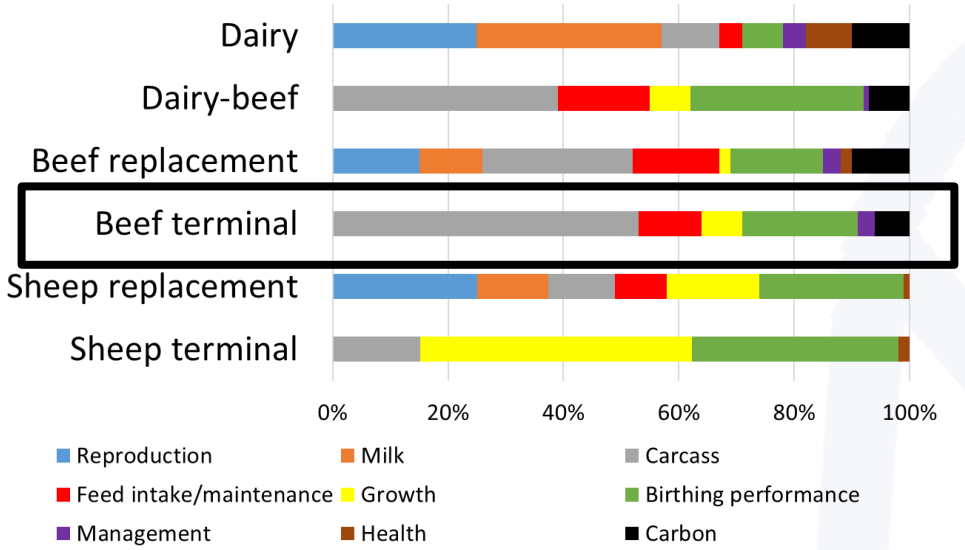


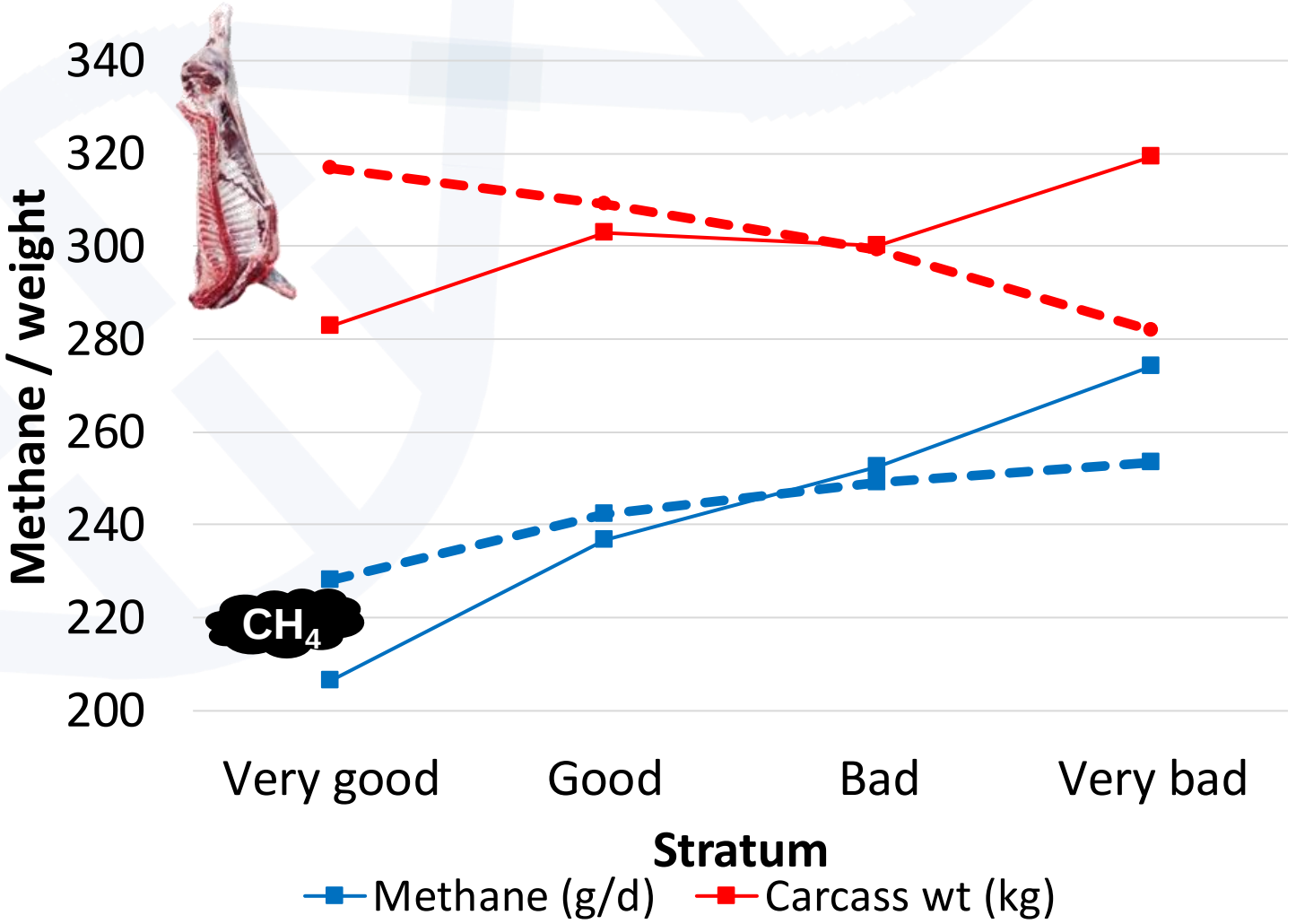
Validation: selection for lower methane





Validation: selection for higher breeding index





- Breeding indexes have the capacity to bring all traits along simultaneously

Take home messages

- Genetic selection is a proven technology
- Should not view methane in isolation
- Previous profit indexes now becoming more sustainable
- Direct selection for methane is possible
- BUT: Need to pool resources to make it happen
- If the phenotype is the King then collaboration can be his kingdom!