FEED EFFICIENCY OF BEEF CATTLE AND MEASUREMENT TECHNIQUES
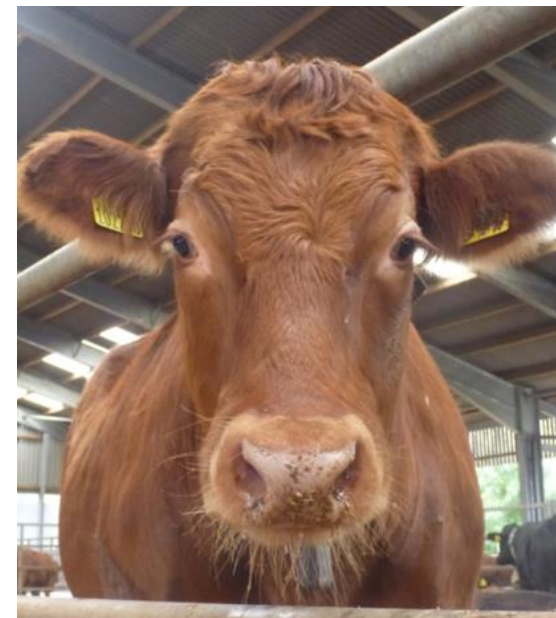# Webinar – 9th October 2019

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Talk outline

- **Financial importance of feed efficiency**

- Methods of expressing feed efficiency
  - Feed conversion ratio (FCR)
  - Residual feed intake (RFI)

- Feed efficiency protocols - equipment and techniques
  - RFI protocols
  - Average Daily Gain (ADG)
  - Feed intake (FI)
  - Body Composition

- Breeding for improved feed efficiency

Economics and feed efficiency

- Provision of feed – up to 75% of variable costs
- Improved feed efficiency - economic and environmental advantages

Feed efficiency → Intake → Same production level → Economic → Enviro. impact
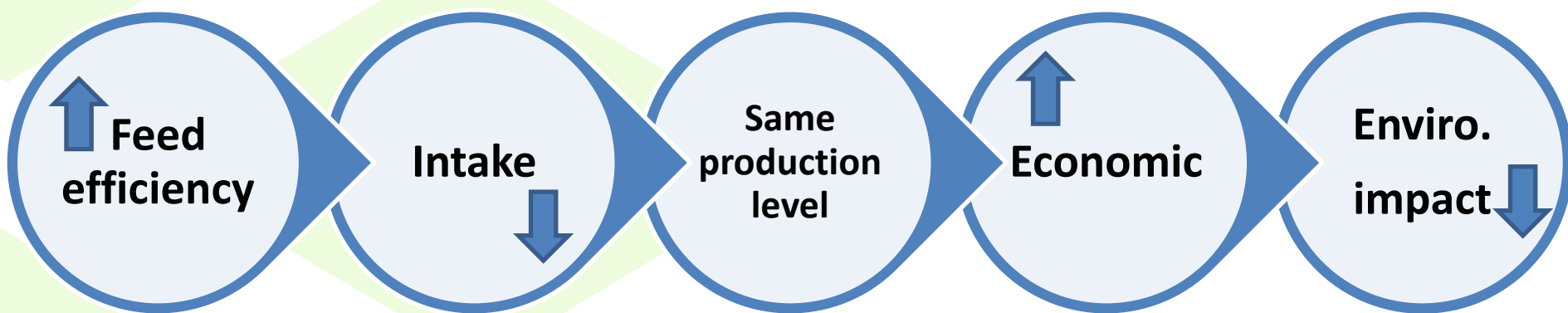
Growing and finishing phase:

- **1% improvement in feed efficiency has the same economic impact as a 3% increase in rate of gain**

Economic benefits of improving feed efficiency

	Comparison	Difference in feed eaten (same gain)	Financial gain
Stabiliser bulls (UK)	Top ¼ vs Bottom ¼	25%	£92/animal over 205 days
Simmental bulls (Ireland)	Top ⅓ vs Bottom ⅓	14%	€35/animal over 105 days
Angus or Hereford bulls (Canada)	Top ⅓ & Bottom ⅓	3.4 kg 'as fed'	C$47/animal over 140 days
Charolais x steers (UK)	Top ¼ vs Bottom ¼	28% (3.8 kg Dry Matter)	£85 over 120 days
Luing steers (UK)	Top ¼ vs Bottom ¼	31% (4.2 kg Dry Matter)	£95 over 150 days

Large variation and moderate heritability estimates means genetic progress can be made

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  - Calculations

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Traditional measures of feed efficiency

- **Feed conversion ratio** = intake / growth
  - Economic representation of a cost of production

- **Feed conversion efficiency** = growth / intake
  - Representation of the efficiency of a biological process

FEED CONVERSION RATIO (FCR) U.S.

6+ 5 3.75

1.8 1.7 1.25

UNITS OF FEED IT TAKES TO PRODUCE 1 UNIT OF MEAT
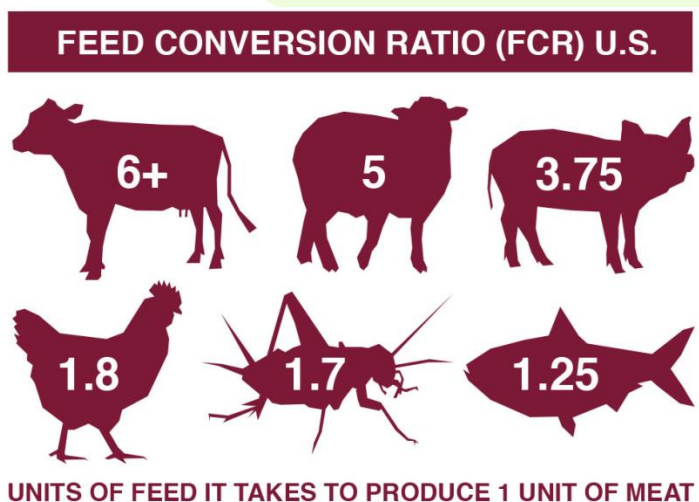
- **Considerable genetic progress with monogastrics using FCR**

- **Monogastrics - lower FCR than ruminants (MORE efficient)**

- **Best measure in ruminants has sparked considerable debate**

- **Some antagonistic relationships with important production traits...**

Breeding for FCR?

Strong negative correlations with ADG, mature size

- Selection for FCR will indirectly:

  – Increase genetic merit for growth (increase ADG)

  – Increase cow mature size

  – Increased maintenance requirements

  – Higher feed requirements and intake

  – Increase feed costs for the herd

  – Increased environmental impact!

Selection needs a measure independent to key production traits → **Residual Feed Intake?**

Residual Feed Intake – what is it ?

- RFI – it is a biological measure of feed use efficiency
  - Koch et al., 1963; more interest since 90's

Net Feed Efficiency (NFE); Net feed intake (NFI); Residual Feed Intake (RFI) – <u>THE SAME TRAIT</u>!

RFI is one that scales feed intake to:
  - the size of the animal (metabolic LW)
  - its rate of growth (DLWG)
  - its degree of carcass fatness (fat depth by ultrasound)

- RFI is a measure of feed efficiency derived "NET" for any:- given unit of animal size (kg); growth rate (kg/d) or carcass fat levels (mm)

Different expressions of feed efficiency

RFI = ACTUAL DMI (A_DMI) – PREDICTED DMI

Predicted DMI - linear regression of actual DMI on ADG, MMLW + FD

| Trait	Definition / calculation
FCR	FCR = DMI / ADG
RFI1	RFI1 = A_DMI-($\beta 0$ + ($\beta 1$ × ADG) + ($\beta 2$ × MMWT))
RFI2	RFI2 = A_DMI-($\beta 0$ + ($\beta 1$ × ADG) + ($\beta 2$ × MMWT) + ($\beta 3$ × FAT))
RFI3	RFI3 = A_DMI-($\beta 0$ + ($\beta 1$ × ADG) + ($\beta 2$ × MMWT) + ($\beta 3$ × FAT) + ($\beta 4$ × REA))

If predicted intake is 10kg; and actual intake 8kg

8-10 = -2 kg/d –VE RFI - EFFICIENT!

Different expressions of feed efficiency
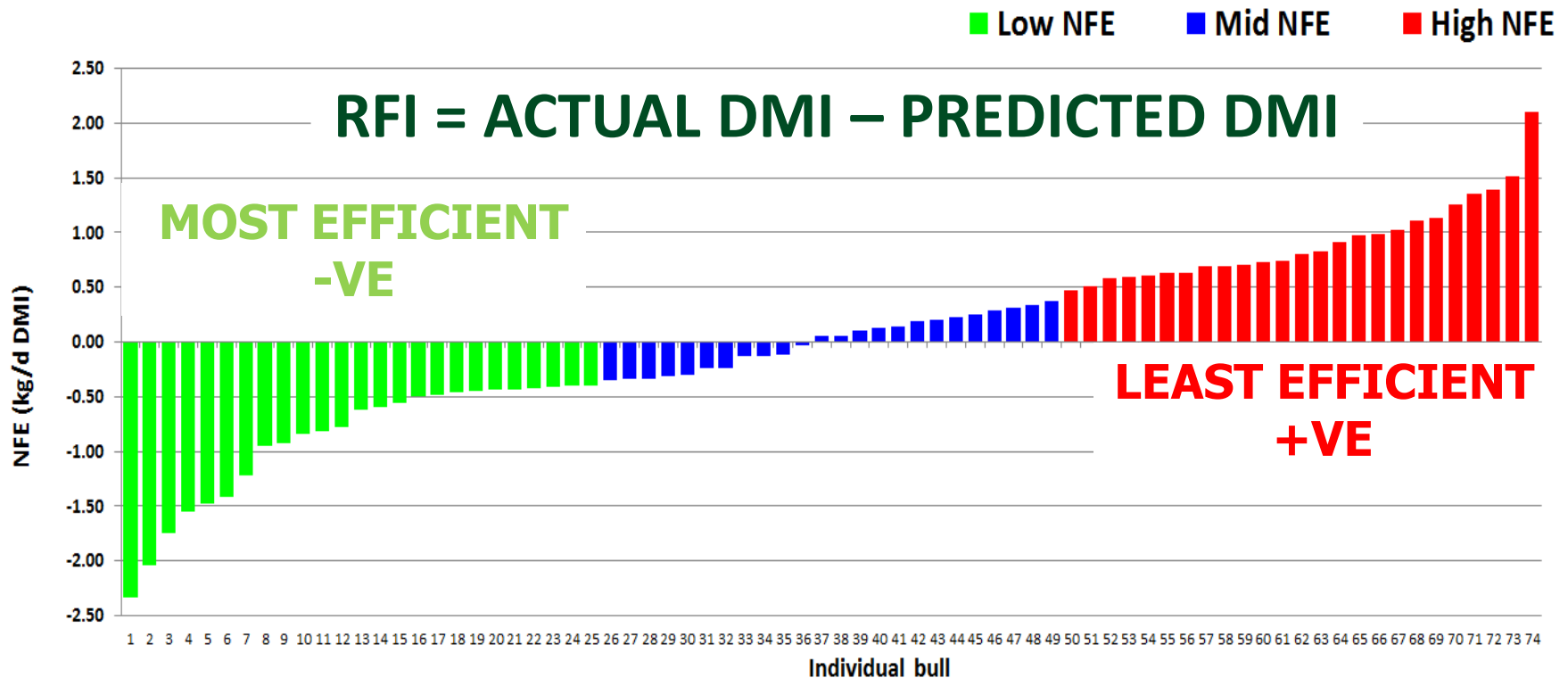
- Efficient animals eat less than expected (**negative RFI**)
- Inefficient animals eat more than expected (**positive RFI**)

UK Stabiliser bulls – RFI results

Batch 7 NFE (78 Stabiliser bulls) — Low NFE
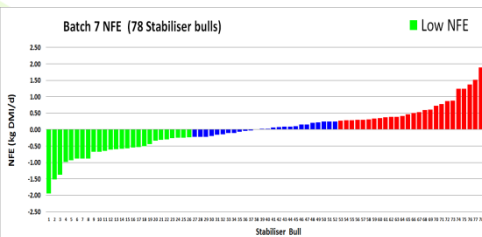
NB: @ feed cost of £155/t DM

- 12 weeks on Wold farm NFE test

	Low RFI	Mid RFI	High RFI
Mean LW (kg)	591	575	579
ADG (kg/d)	1.76	1.66	1.73
Fat depth (mm)	5.4	4.9	5.4
DMI (kg/d)	10.8	11.2	12.4
FCR (DMI:LWG)	6.2	6.9	7.2
RFI (kg/d)	-0.89	0.01	+0.92
Cost deviation from average	-£5	0	+16

- Independent of growth and body size (and composition)

- *Not antagonistically associated with desirable production traits

ANY QUESTIONS?

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  - **RFI protocols**
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  - **Body Composition**

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How do we measure feed efficiency ?

Measure inputs

- Feed intake (Individual)
- Feed composition and quality

Measure outputs

- Liveweight, Average Daily Gain
- Body composition
  - Fat Depth (FD), Muscle Depth (MD)

- **<u>Accuracy</u>** in measurements is essential

Protocols for measuring residual feed intake

Key things to consider:

- Adaptation period

- Test period - length

- Measuring ADG and tools/technologies available

- Measuring individual FI and tools/technologies available

- Measuring body composition (fat and muscle depth)

- Calculating efficiency

Phases of RFI testing

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ADAPTATION	→	TEST PERIOD	→	DATA ANALYSES

ADAPTATION

- **Min. 21 days**
- **28 days preferred**
- **Adapt to facility**
- **Adapt to diet**
- **Training to use "tech"**
- **Data NOT used in calculating RFI**

TEST PERIOD

- **Test length varies**
- **Data recording:**
  - **Feed intake (indiv.)**
  - **Feed composition**
  - **LW (indiv.)**
  - **Body composition (MD/FD)**
- **Data used in calculating RFI**

DATA ANALYSES

- **Data collation**
- **Data checking**
- **Feed analyses:**
  - **Chemical/DM**
- **Calculations:**
  - **ADG**
  - **DMI**
  - **RFI / FCR**

Test period - length

- **No defined "standard"**

- Typically: 70 days; weights every 2 weeks

- Recognised that increased frequency of weighing = shorter test period; reduced cost

- Frequency of LW - important in defining test length

- Start and end of test is **not adequate** for ADG calculation

- Note: ICAR guidelines recommend 60 days test period (*https://www.icar.org/Guidelines/03-Beef-Cattle-recording.pdf*)

LW data frequency	Length of test (days)
Weekly	**56**
Every 2 weeks	**70**
Every 3 or 4 weeks	**112**

Alternative test lengths - ADG accuracy

- Finishing steers; Weekly LW; 56-84 day test lengths

	84	77	70	63	56	s.e.d.	Sig.
R^2	95.6[a]	94.8[b]	93.8[c]	92.7[d]	92.4[d]	0.339	*
ADG (slope)	1.19[a]	1.18[a]	1.19[a]	1.20[a]	1.25[b]	0.013	***
s.e. of LWG	0.070[a]	0.079[b]	0.092[c]	0.105[o]	0.120[e]	0.0028	**
Error bound (%)	12[a]	13.7[b]	15.6[c]	17.9[d]	19.4[e]	0.499	**

- $R^2 > 90\%$ and error bound < 20%

- Test length of 56 days adequate with weekly recording

Hyslop et al., 2012. Proc. British Society of Animal Science Conf.

Good vs. bad example of LW data

$y = 1.6857x + 615.24$
$R^2 = 0.9817$
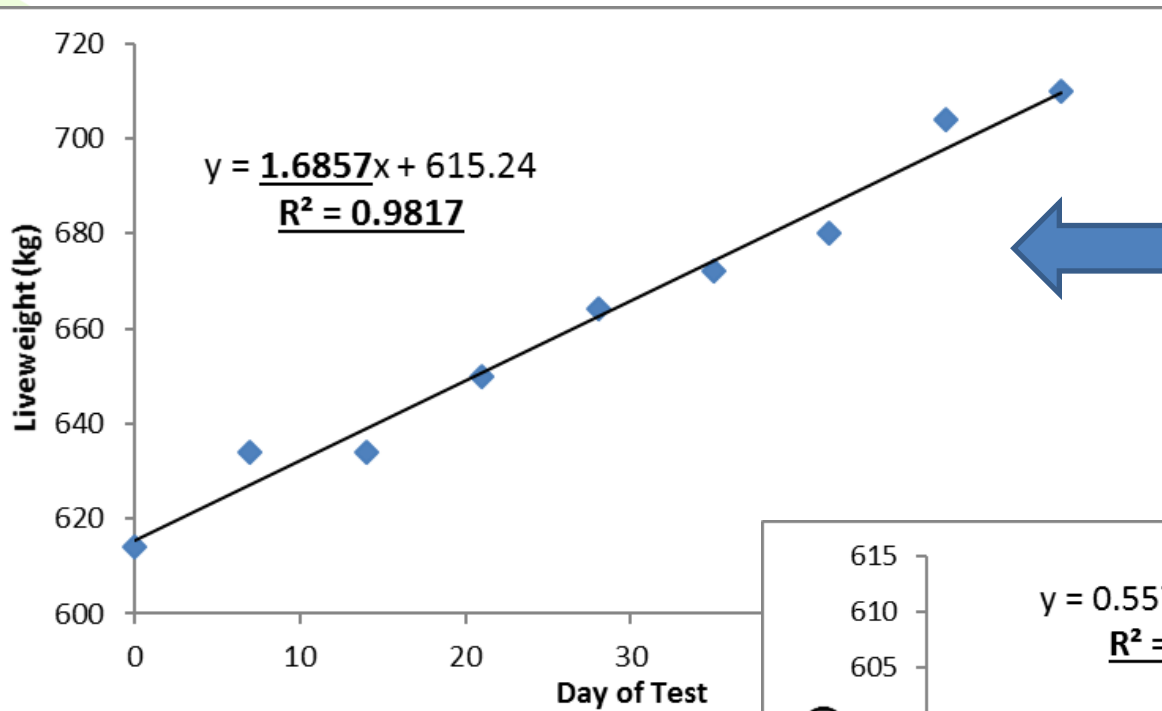
- Good fit
- Robust data
- **$R^2 > 0.90$**

$y = 0.5571x + 580.62$
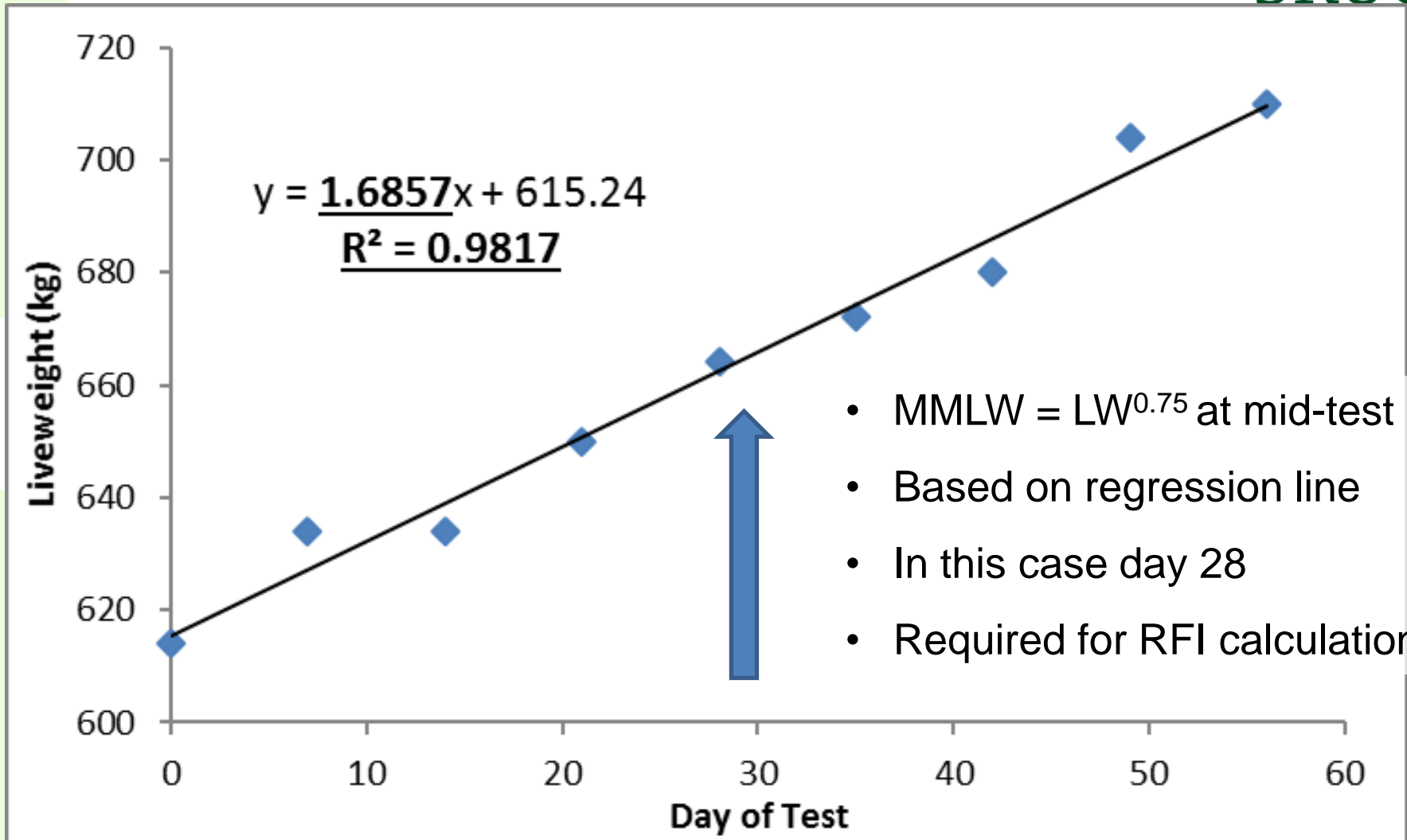$R^2 = 0.6393$

- Poor fit
- Remove data
- Warrants investigation
- Data input error?
- Underlying health issue?
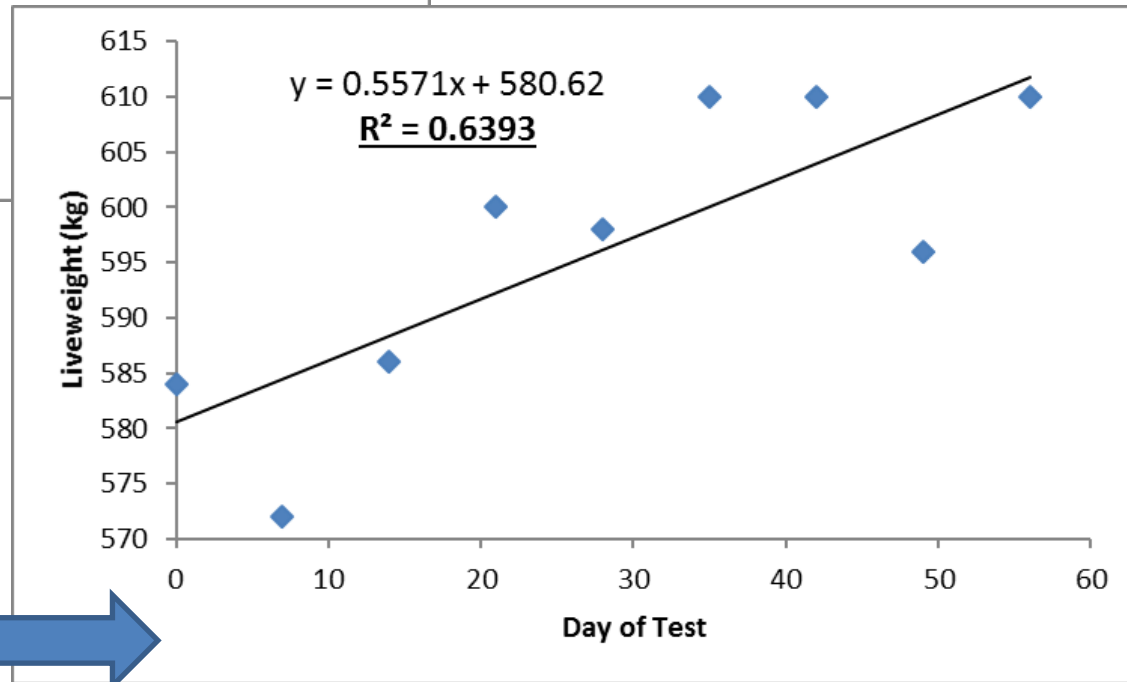
Mid-test Metabolic LW (MMLW)

$y = \underline{1.6857}x + 615.24$

$\underline{R^2 = 0.9817}$

- MMLW = $LW^{0.75}$ at mid-test day
- Based on regression line
- In this case day 28
- Required for RFI calculation

Improving accuracy of ADG estimation

- Increased LW data points

- Regular calibration/checking

- **Use of new automated tools:**

  – Fully automated in-pen crate (e.g. BEEF MONITOR)

  – Fully automated partial weigh scales (e.g. GROWSAFE)
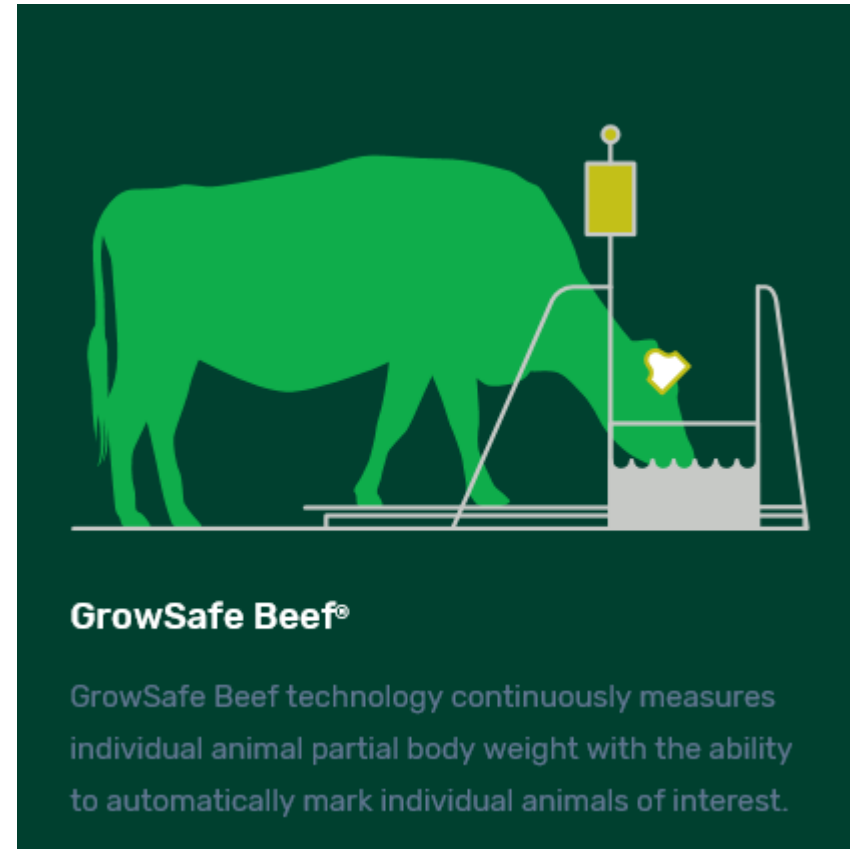
AUTOMATED WEIGH PLATFORM – UK EXAMPLE

- **Fully automated** weight platform

- Integrated water trough

- Low frequency EID

- Every visit to trough

    – recorded weight

- Multiple weights per day

- Accurate ADG calculations

- No handling

- Automatically sent to cloud

- "user-friendly" APP.

- Min 1 month data required
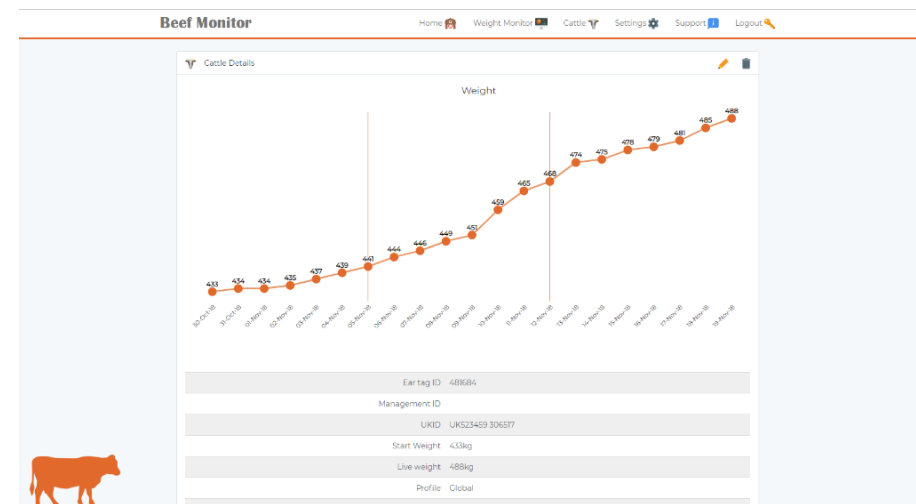
Other systems for automated LW recording

- Measure full or partial body weight (PBW)

- **Weight platform integrated with feed or water station**

- Electronic identification
  - ear tag / collar

- Manufacturers:
  - Growsafe (Canada)
  - Biocontrol (Norway)
  - HokoFarm Group (The Netherlands)

GrowSafe Beef®

GrowSafe Beef technology continuously measures individual animal partial body weight with the ability to automatically mark individual animals of interest.

https://growsafe.com/our-platform/

Feed intake recording

- Feed apportioned based on group recording not sufficient
  - **large variation and inaccurate**

- FI can be obtained when **individual** feed intake data is recorded for a minimum **45 days**
  - less than required for accurate measure of ADG

- Tests need to be longer than this to achieve 45 days of good data
  - accommodate computer and equipment malfunctions
  - measurement days (e.g. fat depth measures, weighings)
  - disturbances in the pen (bedding, visits, maintenance)

Technology advances – feed intake recording

- Advances in technology – since 1990's

- Individual feed intake measurement at large scale

  – Fully automated and electronic feed intake bins

  – Large quantity of data – feeding behaviour and intake

  – Many different commercially available examples

www.biocontrol.no   www.hokofarmgroup.com   www.bigbeef.co.uk

Example system – HOKO farm group

EID reader

Photoelectric reflective sensor

Entry door

EID Tag

Weigh cells

Practical limitations of feed intake recording systems

- Some practical limitations:

  – Not high throughput – each unit serves ~3 animals

  – Labour intensive

  – Expensive to install and maintain

Research station SRUC
www.sruc.ac.uk

Elora Research station
Univ. Guelph, Canada
www.uoguelph.ca

Stabiliser testing station UK:
www.bigbeef.co.uk

Wagyu testing station Australia
www.wagyu.org.au

Key things to consider

- Feed should be provided *ad libitum*
  - Avoid data bias due to restricted access to feed
  - Stocking density based on manufacturer recommendations
  - Facilitate normal unrestricted feeding behaviour

- Examples of instances where feeding may be restricted:
  - Removal from pen – maintenance; equipment failure, sickness, collection of related data (e.g. US fat depth)

- Feed provision should include 5% more than requirements

- Feed intake data on days where animals do not have *ad libitum* access to feed should **not** be used in computing daily feed intake

Bedding material is important

Straw bedding

Sawdust
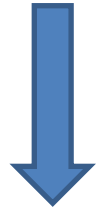
Dry matter intake (DMI)

- Average daily intake should be reported on a **DM basis**

- Removes variability in moisture content across diets

- Increases comparability across tests / studies

- Diet characteristics:
  - Ingredient composition – daily
  - Daily samples of diet / ingredients
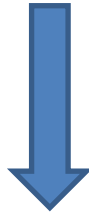 - Chemical composition (inc. DM content)

Measuring body composition

Fat Depth
Muscle Depth

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| Adaptation | Test Period |

- Differences in FD = 5-9% of variation in DMI

- "real-time ultrasound"

- **End of test** to ensure phenotypic variation FD

- Enables **composition** of LWG to be incorporated into RFI model

- Guidelines established by breed society

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Selection for RFI

RFI – better as a genetic improvement tool than FCR

Significant animal-animal variation in RFI exists in beef:

- huge scope for genetic improvement

- moderately heritable - genetic progress can be achieved – 0.16-0.44

Independent to performance traits

- Attractive for breeders

- Easily incorporated into selection index

- FCR negative association with performance (e.g. mature size and ADG)

Outcome of selection for RFI

Selection for RFI should:

- Produce animals that are more biologically and economically efficient

- Result in animals which consume less feed for the same output

- Result in reduced methane per kg product

- Economic benefits (reduced feed costs)

Selection for RFI should not affect:

- – Mature cow weight

- – Carcass quality

- – Meat quality

- – Reproduction and fertility traits

Where are was as an industry?

Progress slow

- Cost / availability of facilities for feed intake recording – largest barrier

- Capital cost and upkeep of equipment - limited to research units until recently

- Commercial testing stations are evolving – will accelerate progress

Vital:
- Technology developments
- Access to feed testing stations

Industry drive and awareness spreading rapidly!!

International activity

- Extensive international research activity
  - Australia, Canada, USA, Ireland, UK

- No clear agreement on which measure of feed efficiency should be used:

- Use of RFI (or NFI) most common (Australia, Canada, UK)

- Generating EBV's for feed intake and incorporating into multi-trait selection index becoming more popular (Ireland, USA)

- Common challenge – **industry uptake**

- Most success achieved through industry collaborations, using commercial testing stations

Lessons learned

- Involvement of industry from outset is key:

  – Breed societies – drive momentum and uptake

  – Commercial testing stations – to achieve industry buy-in and facilitate continued recording

  – Co-funding (public and industry co-funding)

- Establishment of agreed industry standards for recording important

- Agreed protocols to reflect common industry management practices – important to ease recording

- Demonstration of value of selection and genetic improvement important to achieve industry buy-in

UK – Stabilisers – ww.bigbeef.co.uk

- Large **industry led** project "IMPROBEEF"

- Commenced 2011

- Established first **commercial** facility for feed intake recording

- Developed genetic evaluations for RFI (NFE)

- $h^2 = 0.37$ (±0.11)

- EBV's now up and running

- Limousin and Aberdeen Angus

  – 2500 records collected so far..

- **Research** and **commercial** testing stations

- **Industry collaborations**

- **Genetic parameters** estimated:

  – RFI (h^2 – 0.23) and production traits

- Updated breeding objective, refreshed economic weights for current and new (terminal) traits (daily feed intake)

THANK YOU!

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