The role of small ruminants in meeting the global challenges for sustainable intensification in Europe

J. Conington

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H. Wishart, L. Bünger

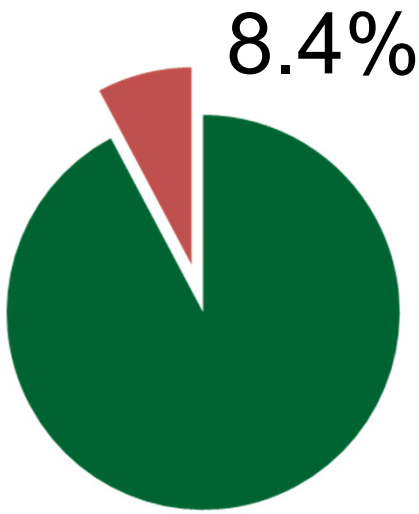
EAAP, Copenhagen Aug 2014

Leading the way in Agriculture and Rural Research, Education and Consulting

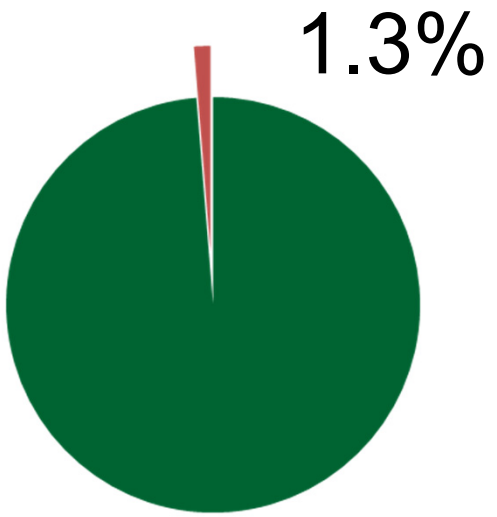
Introduction

- Context
  - Current role of small ruminants in Europe
  - What are the main global challenges?
    - What are the drivers?
- **Technical opportunities for precision-led farming**

How important is Europe *vs* the world?



1.16 bn sheep



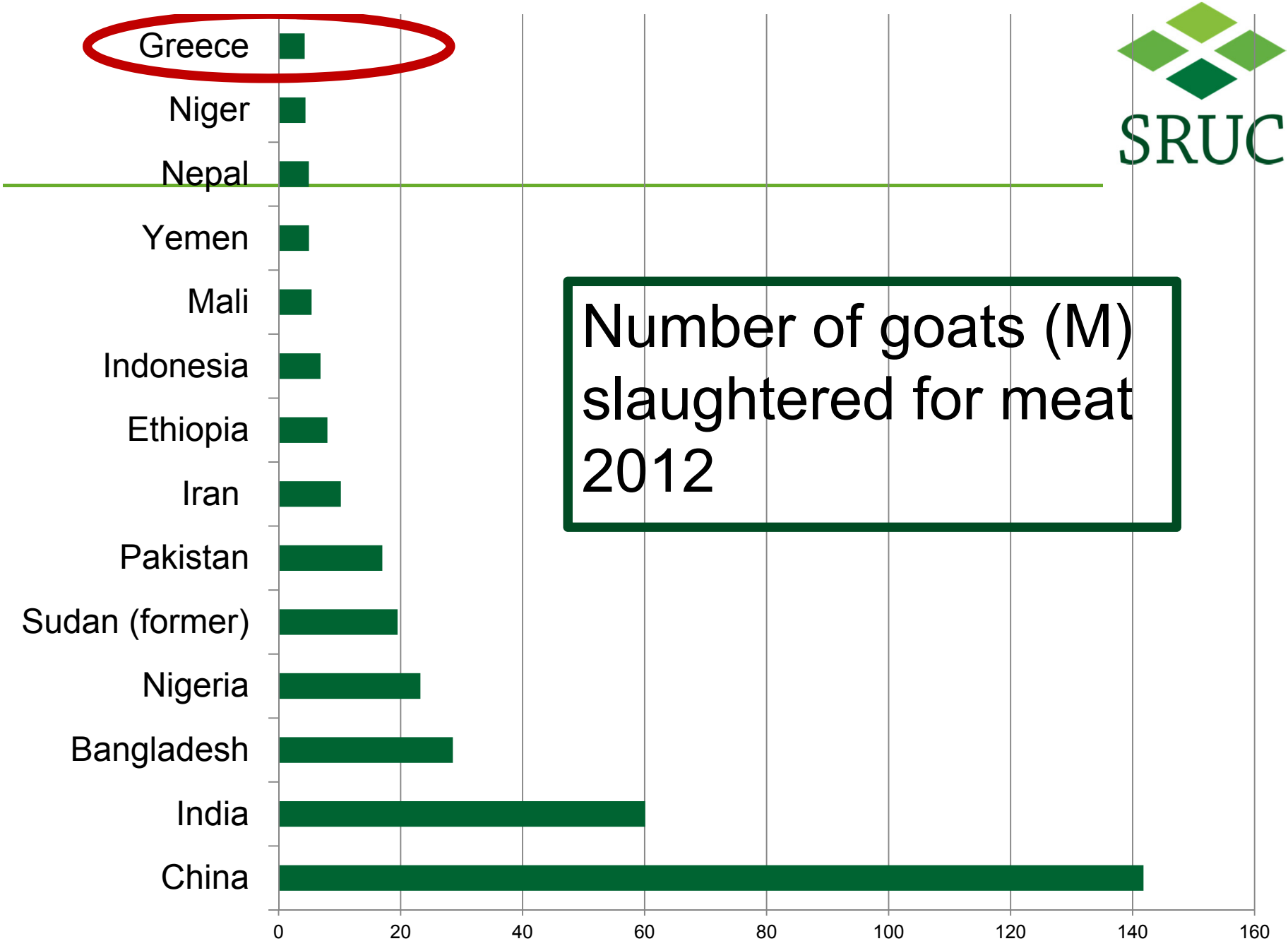
996m goats

Number of animals in the world

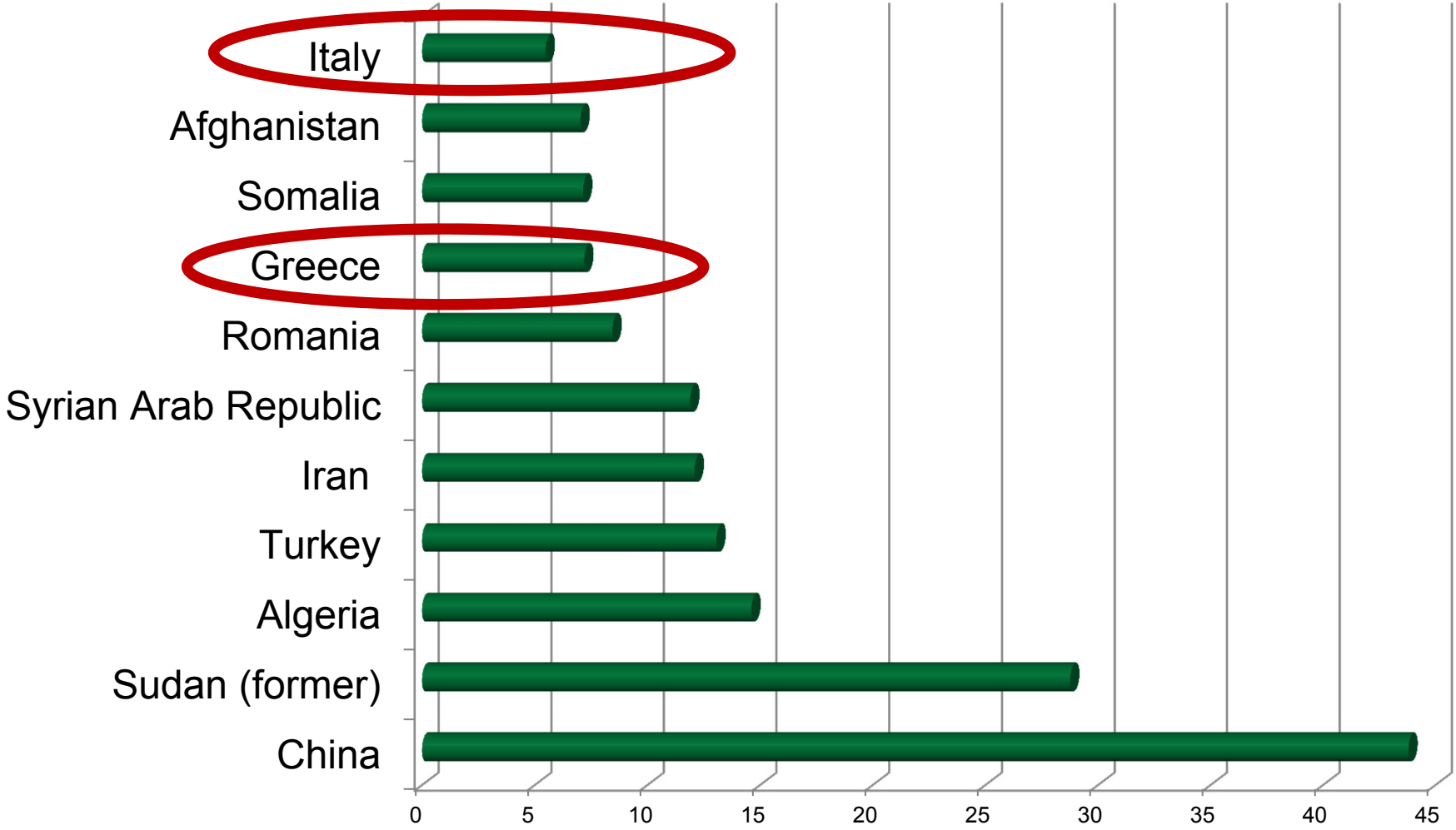
Numbers of sheep - who are the big players?

Number of sheep (M) Slaughtered 2011

Numbers of meat goats - who are the big players?


Greece
Niger
Nepal
Yemen
Mali
Indonesia
Ethiopia
Iran
Pakistan
Sudan (former)
Nigeria
Bangladesh
India
China
0
20
40
60
80
100
120
140
160
Number of goats (M) slaughtered for meat 2012

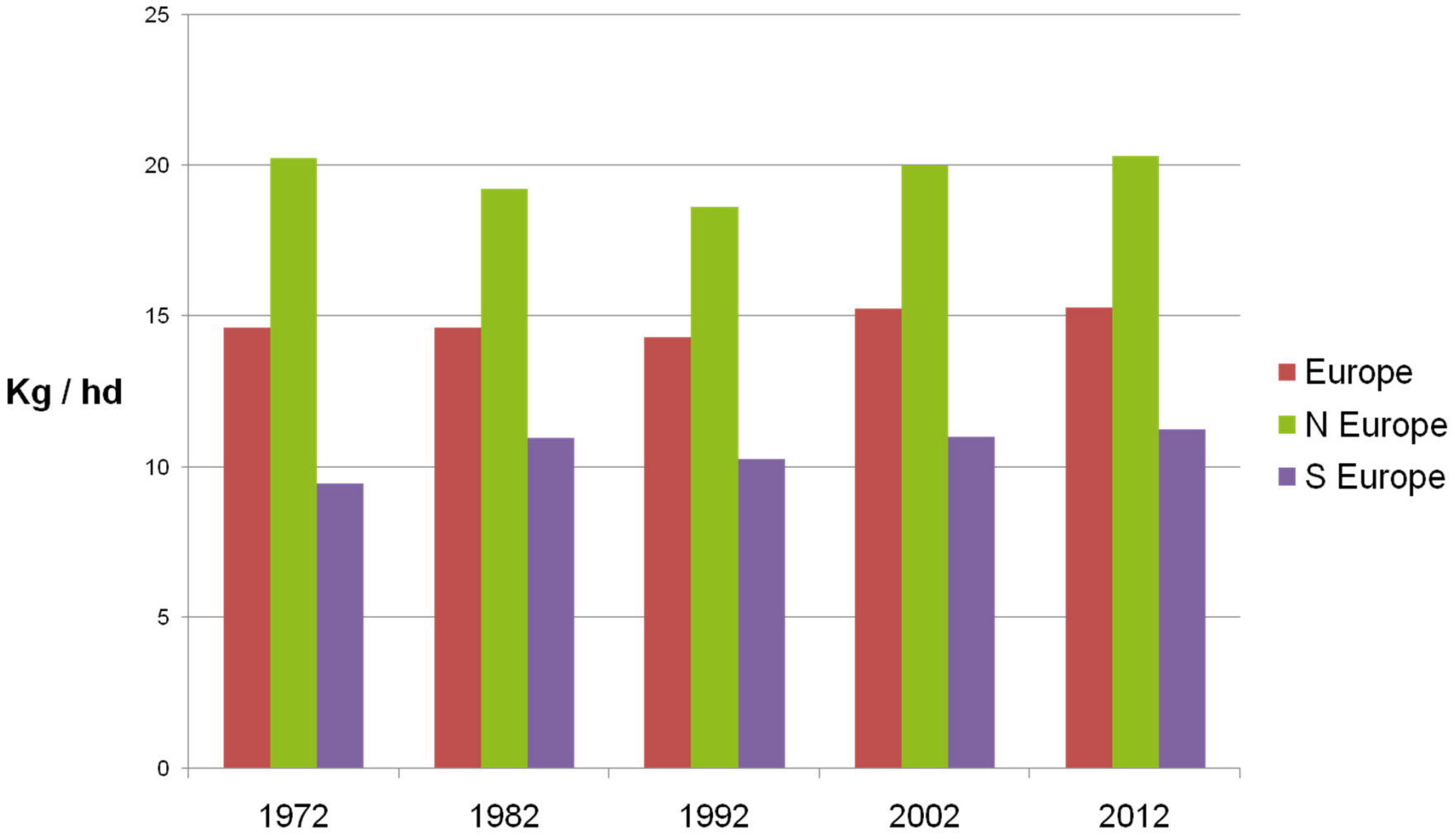
Milk sheep (no. head) (M)



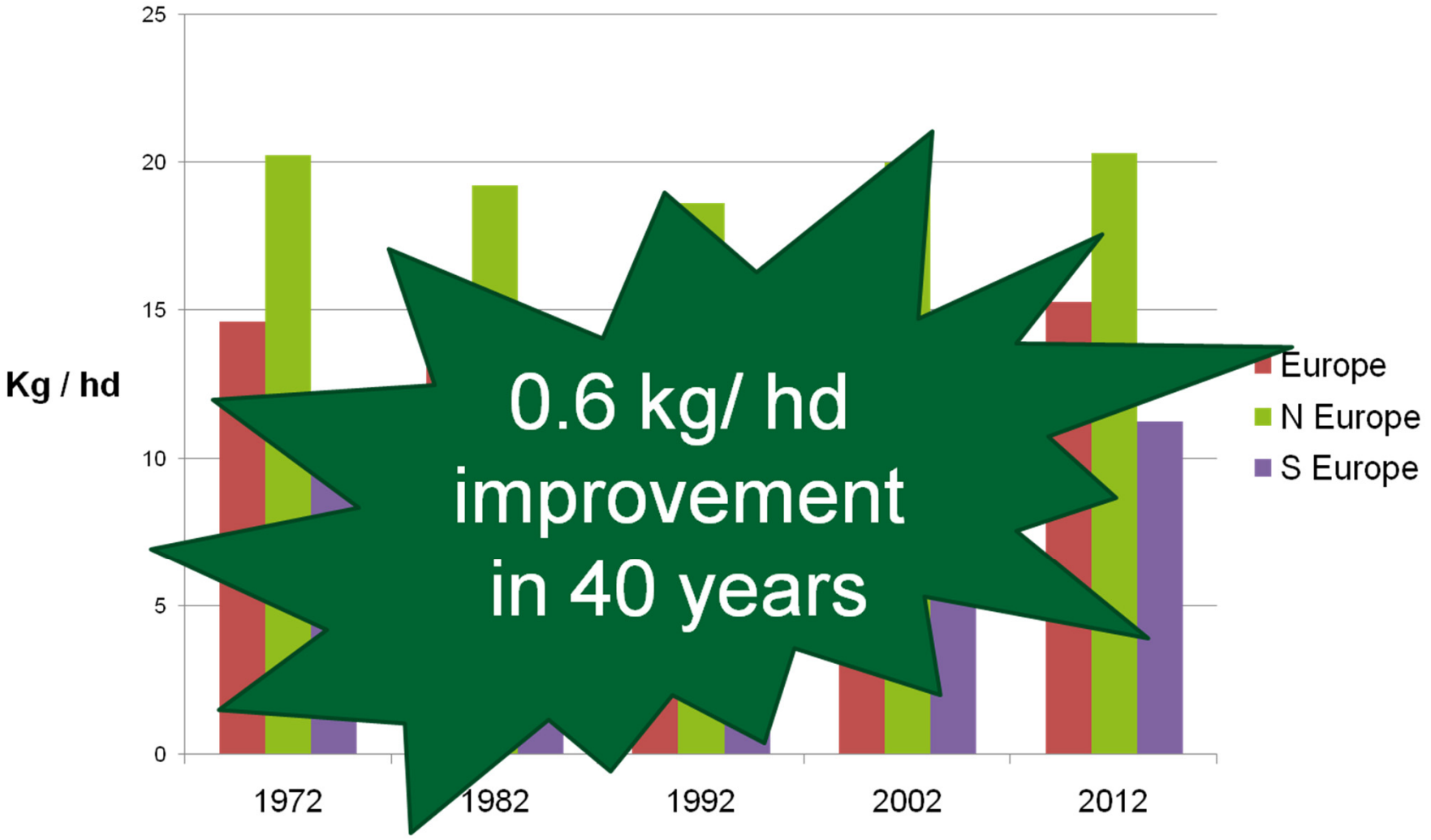
Milk supply

Species	% world milk production
Cow	84.6
Buffalo	11.8
Goat	2.1
Sheep	1.3
Other	0.2

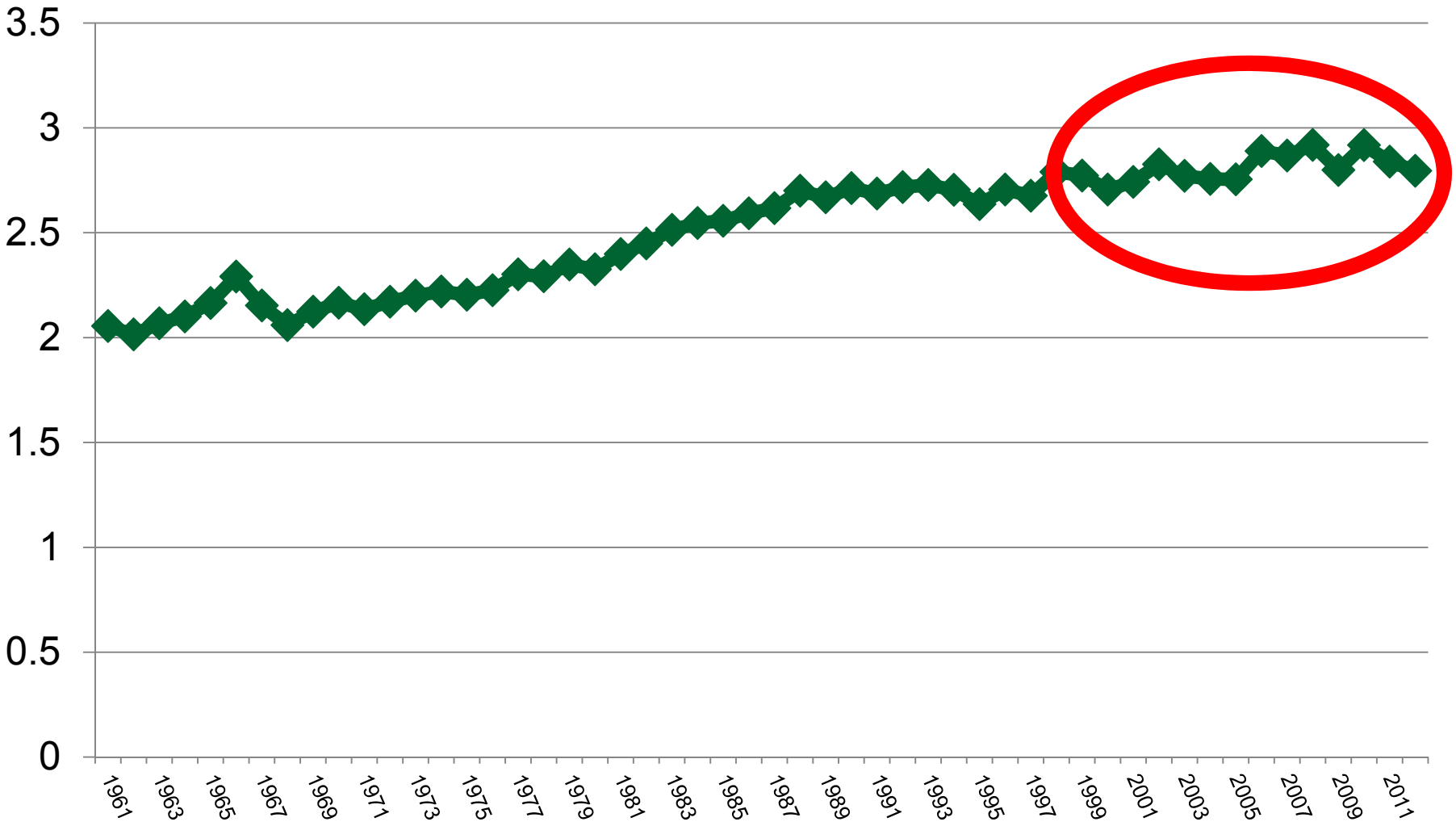
EU - static levels of sheep meat production / hd



Static levels of sheep meat production / hd



EU sheep milk production (Kg milk, Million Tonnes)



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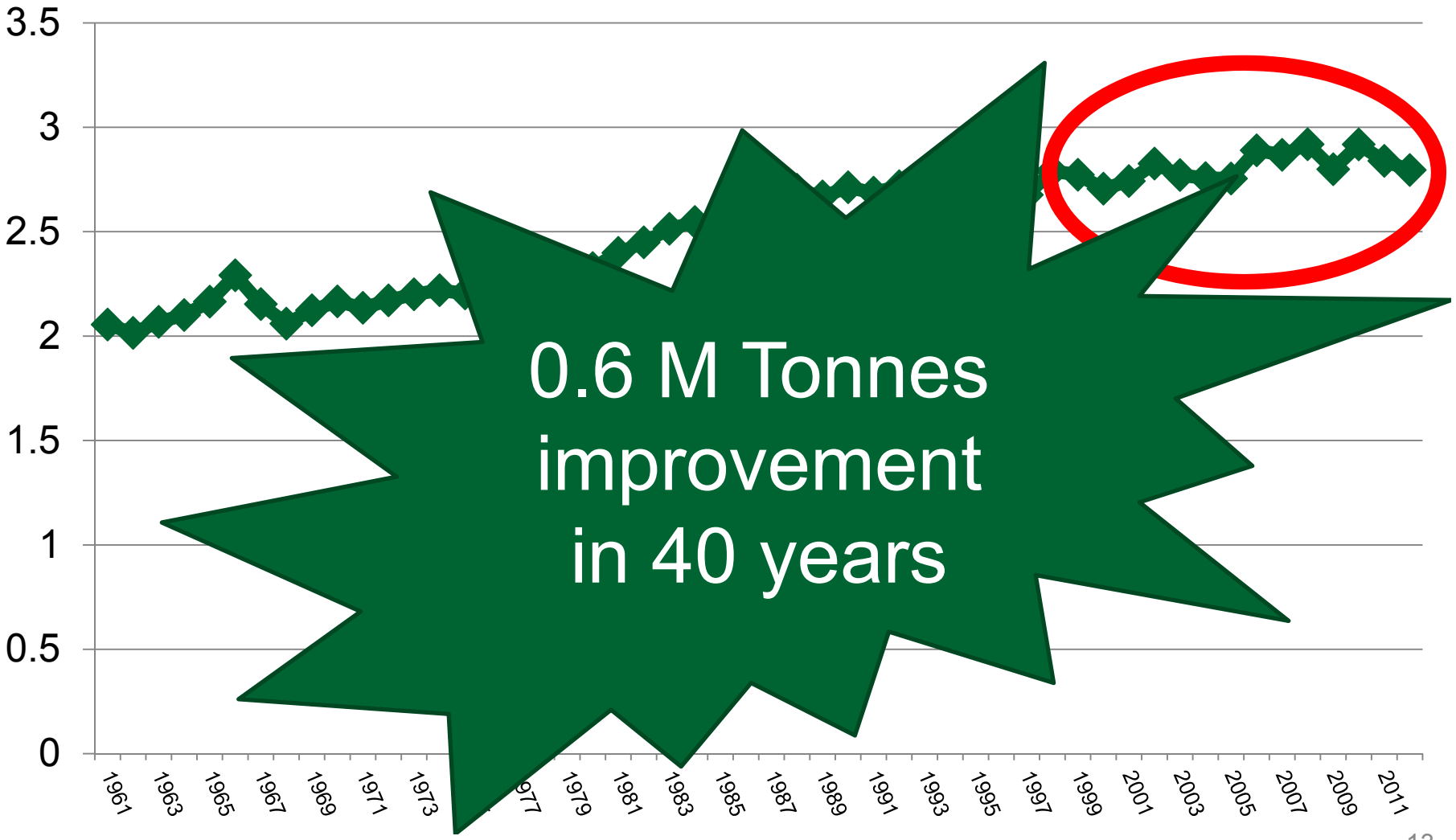
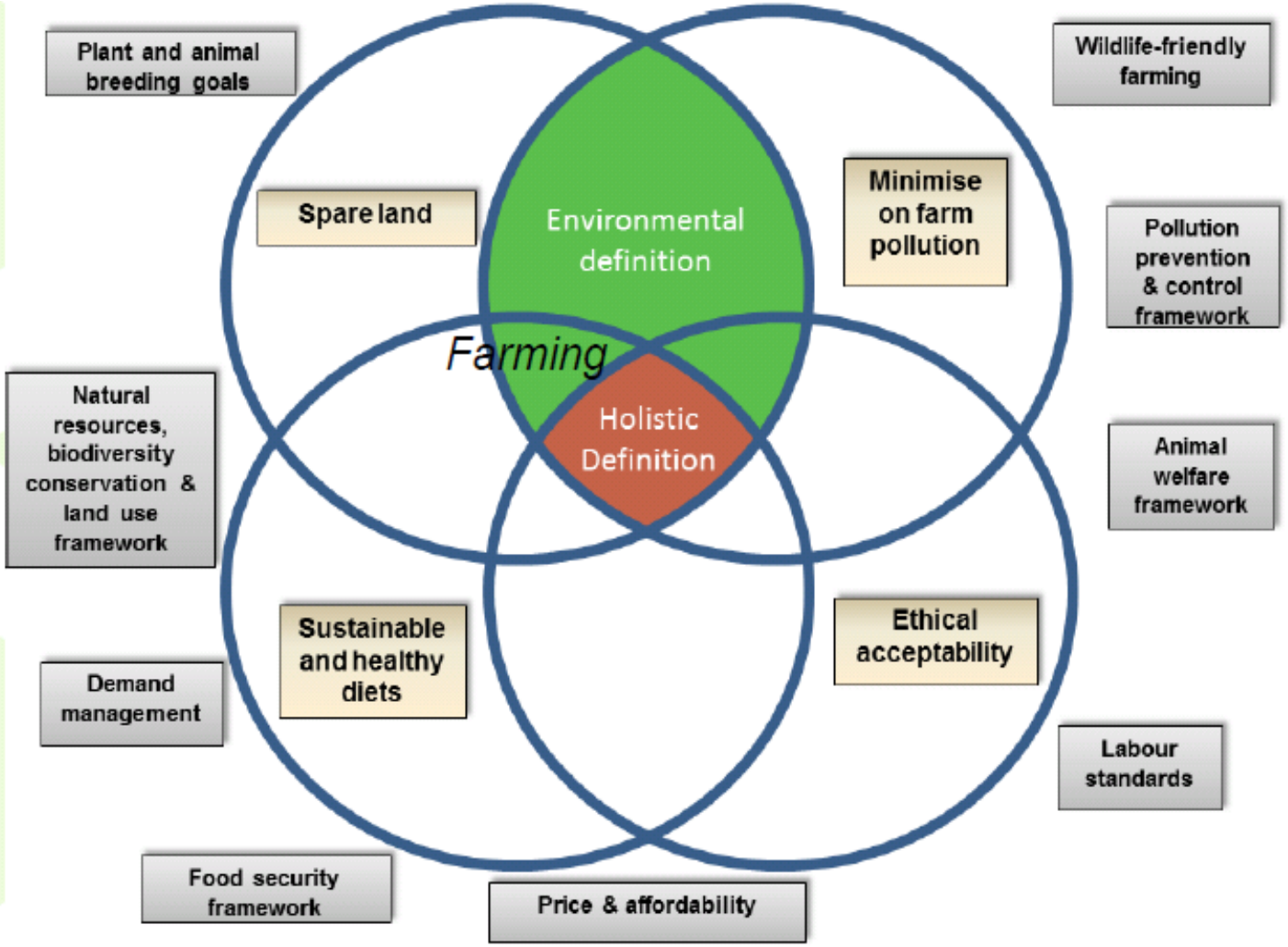


Main challenges?

- Population growth
  - 7.2bn 2013 → 9.6bn 2050 (UN, 2013)
  - Most growth in developing nations esp. Africa
  - Need for increase in food production

- Climate change
  - Water availability
  - Feed and Forage availability - seasonality
  - Extreme weather events

Sustainable intensification



*Garnett T and Godfray C (2012). *Sustainable intensification in agriculture. Navigating a course through competing food system priorities, Food Climate Research Network and the Oxford Martin* Programme on the Future of Food, University of Oxford, UK

Sustainable intensification ?

- Developing nations = Enabling / empowering ~500 m small farmers providing >80% food to become technically proficient
  - (Far more complex than just technical know-how)

Sustainable intensification in Europe?

Assuming past static demand & supply……

- Reduce costs, increase efficiency, lower impact
  - Producing the same from less, or more without corresponding increases in use of energy, water, feed, forage, land & high regard for animal well-being

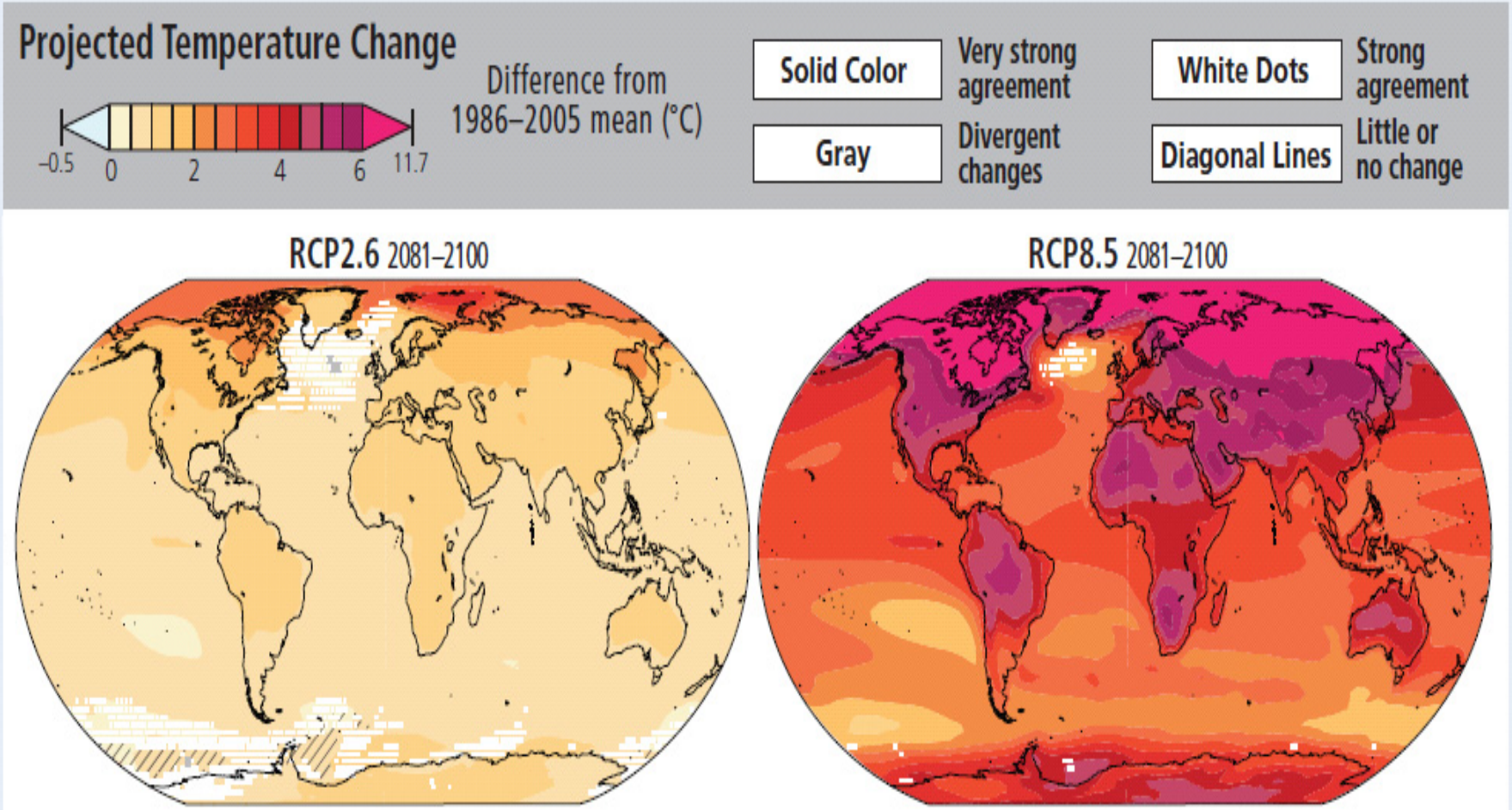
HOW?

Getting it all right!

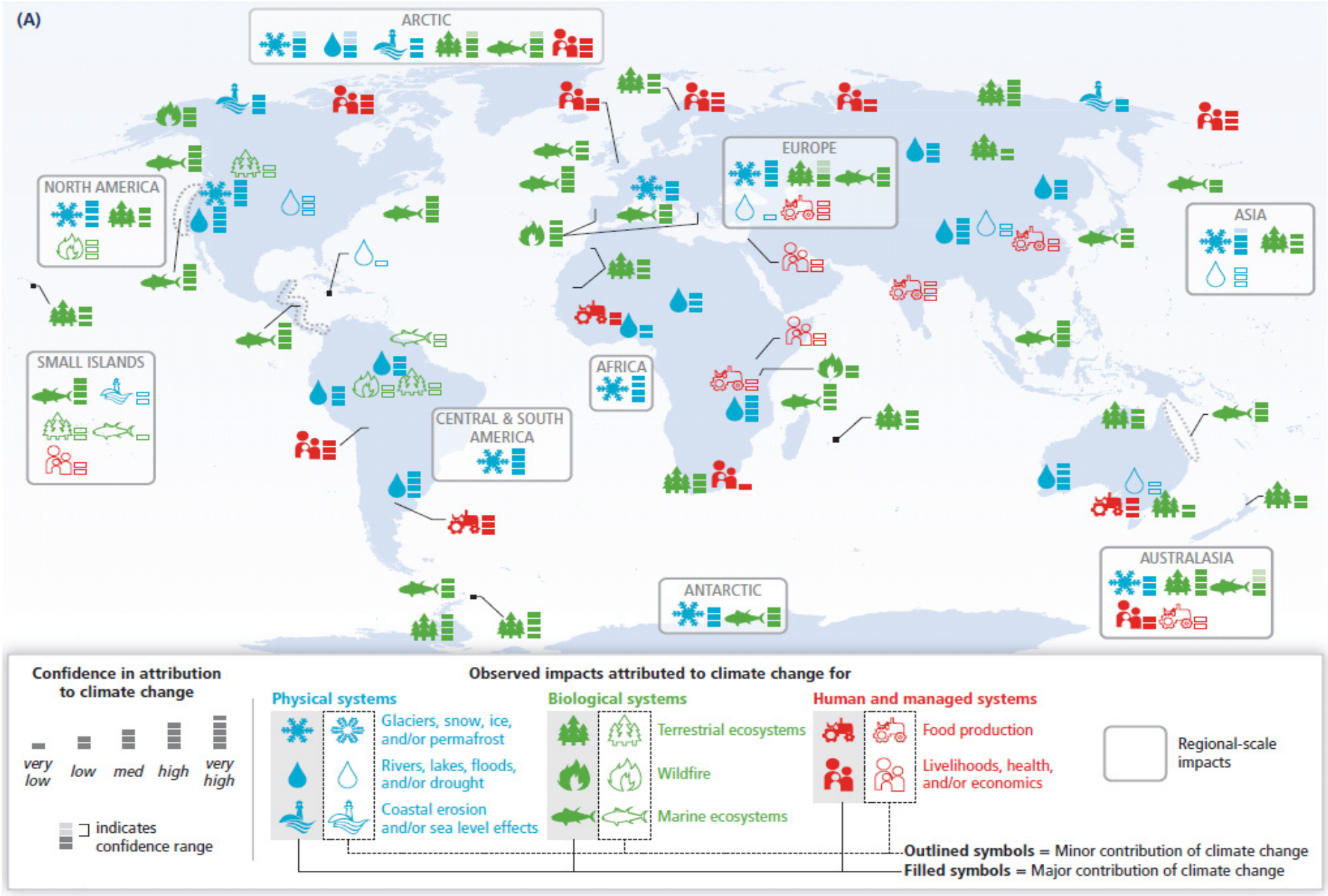
- Breeding*
- Livestock system
- Feeding
- Disease
- Labour use

- & post-farm considerations
  - E.g. Target market

IPCC projected temperature changes for low & high emission



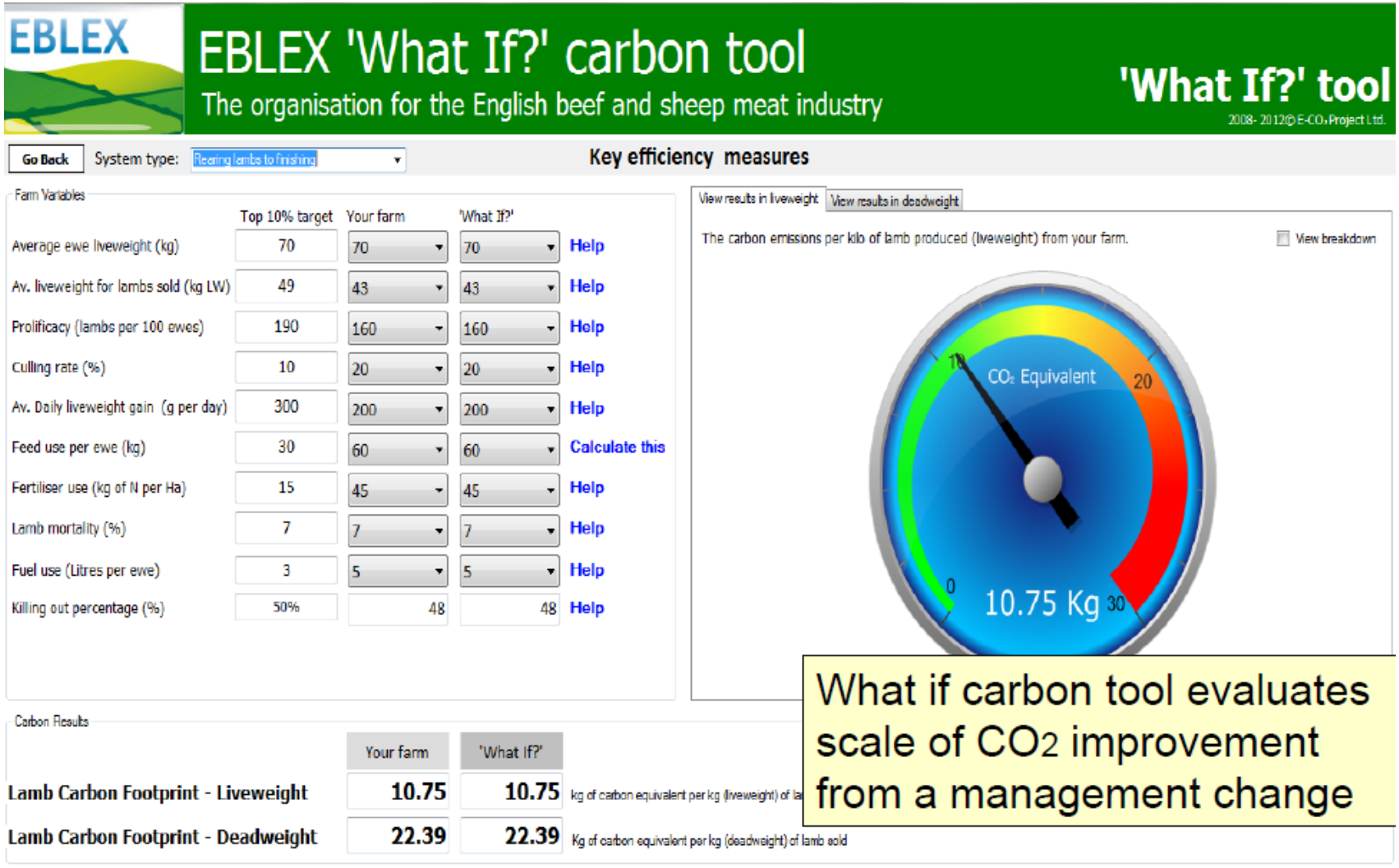
'Climate change, Impacts, Adaptation and Vulnerability IPCC, 2014'



'Climate change, Impacts, Adaptation and Vulnerability IPCC, 2014'

Adapting to climate change

Carbon calculator

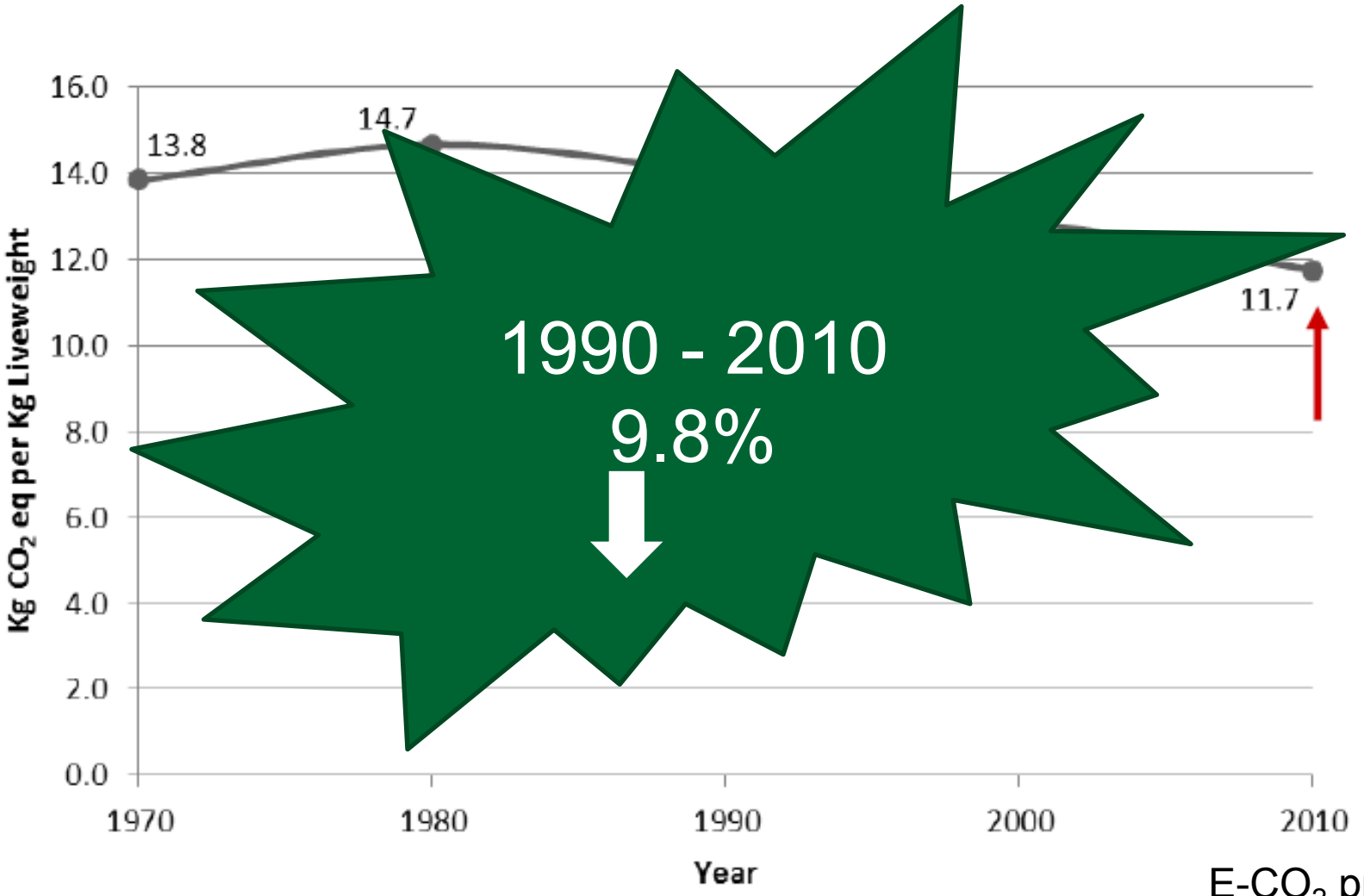


GHG savings from sheep improvements

Area	Improvement target	GWP100 Saving (kg CO2 eq/kg LW
Fertility Efficiency	+ 10% Lambing %	0.18
Increase lamb slaughter weight	+ 2kg	0.36
Feeding Efficiency - Feed quality improvement	- 5kg feed per ewe / yr (55 – 50kg)	0.08
Lamb Mortality	- Reduce lamb losses by 2% (7-5%)	0.18

Source: EBLEX

UK sheep industry carbon footprint already on track



Breeding for increased performance in lowland (meat) sheep ↓ CH_4

Cottle, D.J. and Conington, J. 2013. J. Agric. Sci. 151: 6 872-888

Main points

✓ achieve Gov't targets to reduce CH_4 by 30% in 20 yrs through selective breeding

Extensive sheep – benefits depend on the breeding goal traits & units of expression

Lambe, N.R., Wall, E., Ludemann, C.I., Bunger L. and Conington, J., 2014.

	Benefits/ costs of 1 unit change in trait Benefit = positive number, cost = negative				
	kg CO_2e/ kg lamb carcass	kg CO_2e/ kg meat product	kg CO_2e/ breeding ewe	£ CO_2e/ kg lamb product *	£ CO_2e/ farm*
Weaning WT (kg)	0.15	0.10	1.62	0.004	4.30
Mature size (kg)	-0.79	-0.44	-8.75	-0.02	-23.18
Maternal weaning wt (kg)	0.17	0.12	1.83	0.004	4.84
No. Lambs weaned (no.)	0.27	0.11	-1.39	0.01	-3.69
Lamb survival (%)	0.31	0.13	-1.60	0.01	-4.24

Main efficiency elements affected by breeding

- Quantity of product per offspring/ time period
- Disease resistance
- Quality of product
- Body weight of breeding female
- Growth rate of offspring
- Efficiency of food conversion

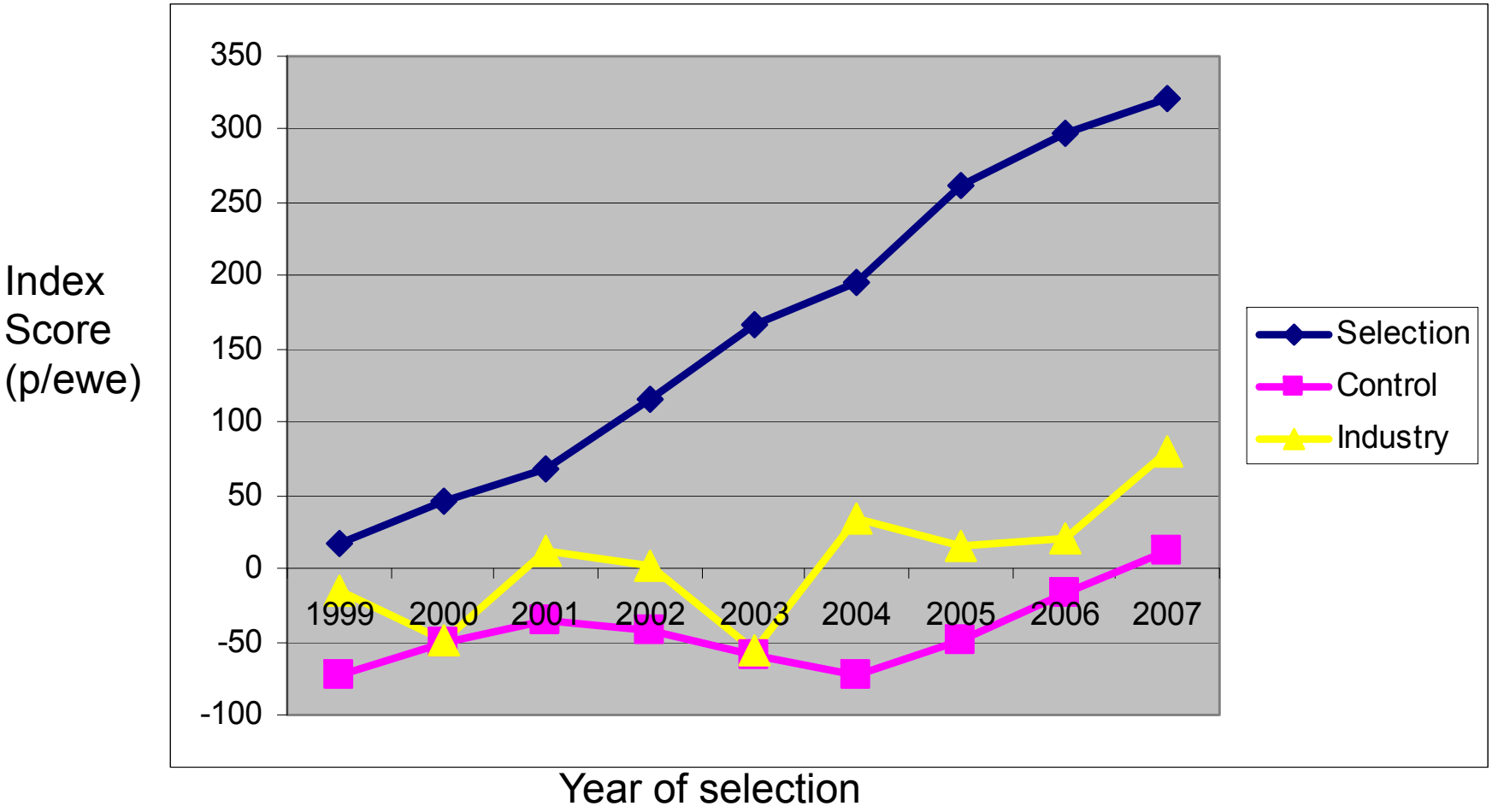
Hill sheep index (since 2000)

Breeding goal traits

Ewe traits	**Lamb traits**
mature size	weaning weight
longevity	carcass fat class
lambs lost	carcass conformation
lambs reared	carcass weight
maternal wean wt	

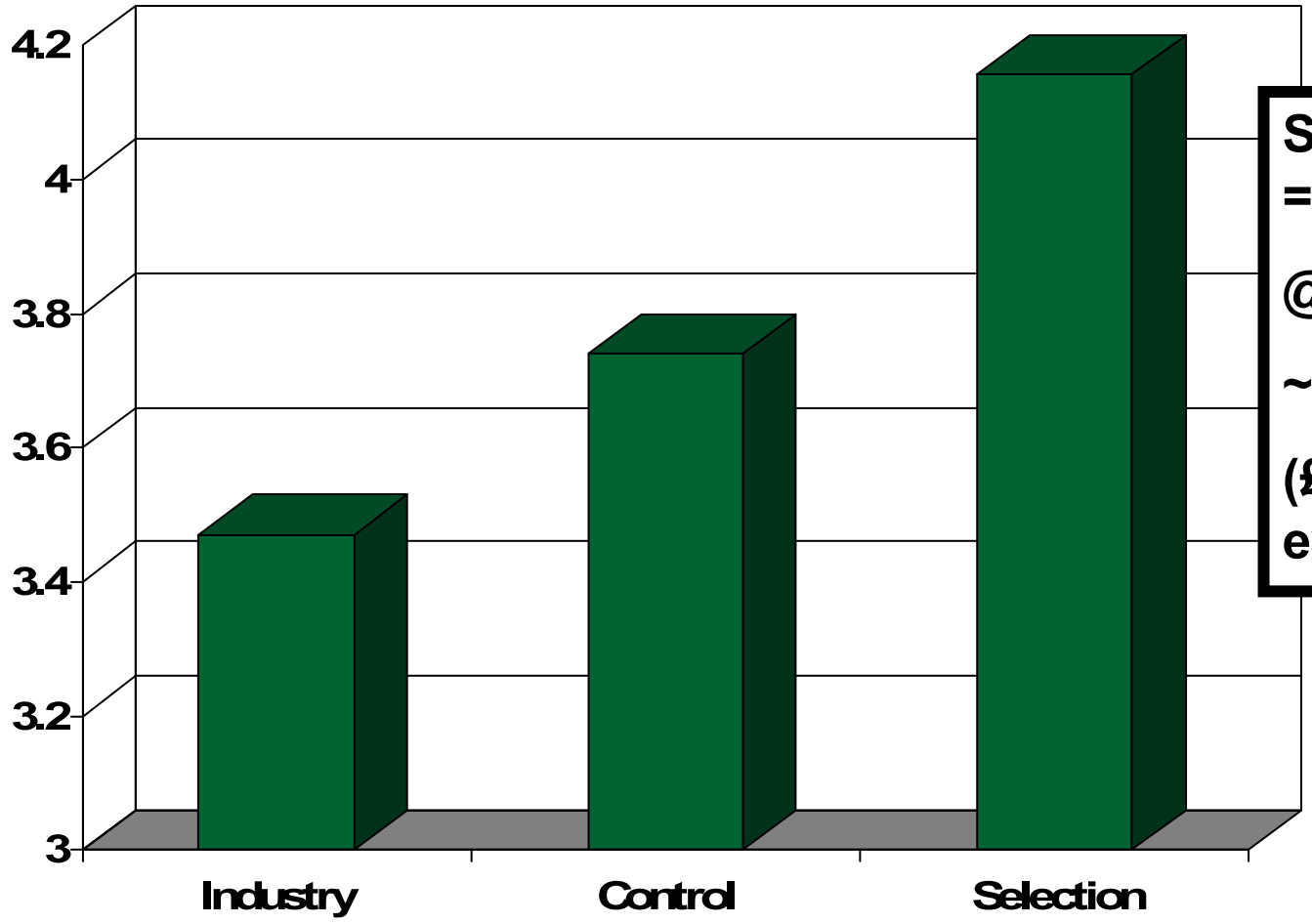
(Conington *et al*., AS 2001; JAS 2004; AS 2006)

Comparison of 3 ‘lines’ managed as one flock



Lambe *et al., Sm. Rum. Res.* 2014

Cumulative no. lambs born (2003-5)/ewe



S-C line diff. =0.41 lambs

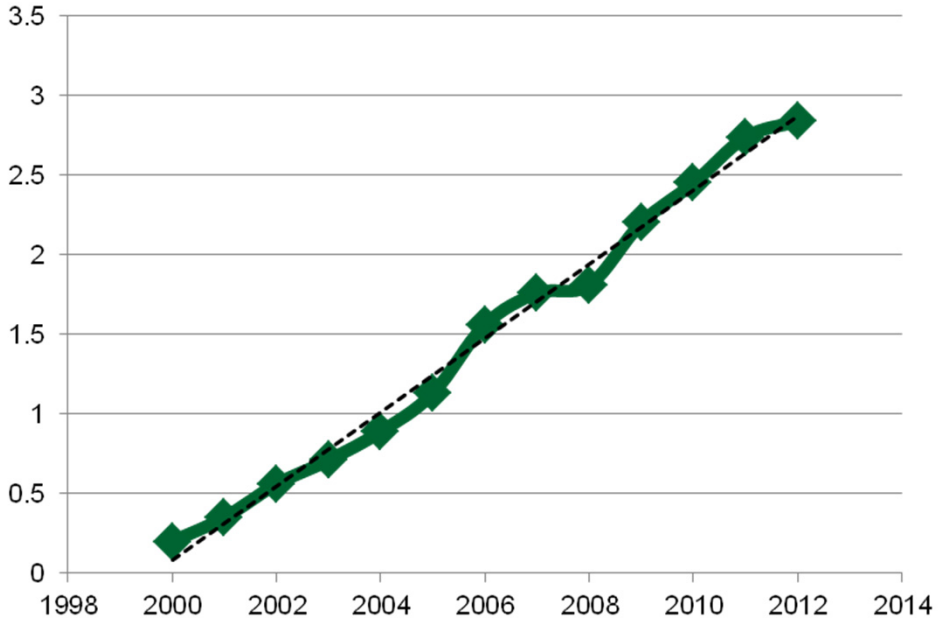
@ £80/lamb

~ £32.80/ ewe

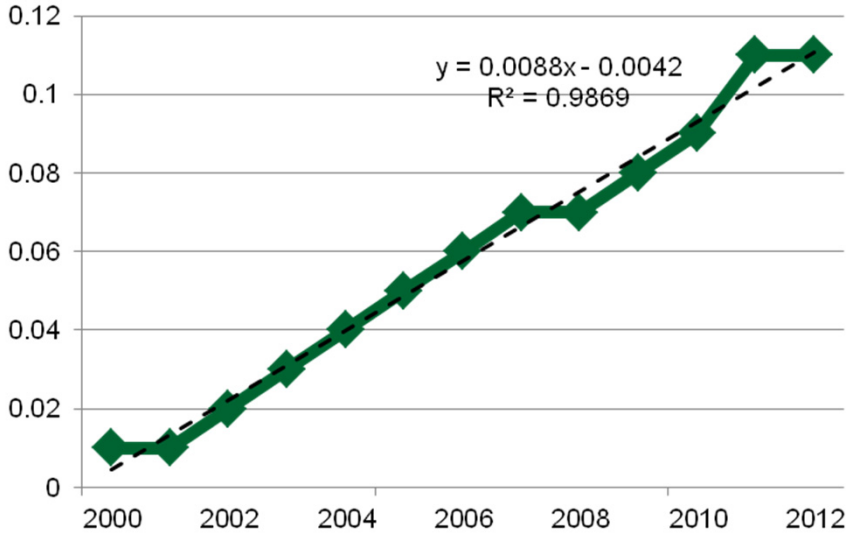
(£9,840 for 300-ewe flock)

Daughter performance of 2000 - born sires

Breeding for efficiency - sheep



Scan weight (21 wks) EBV



Litter size EBV

Source: Signetfbc.co.uk

9 x Focus Farms; 6,000 lambings; 6 years
Demonstrated financial gains “High vs Low”

Lambing Year	Gross Return (£/Ewe)					
	Dalmeny	Hazelbank	Kinnahaird	Rotmell	Westerhall	Whitchesters
Breed	Texel tups on Lleyn x ewes	Purebred Lleyn	Texel tups on Mule ewes	Purebred Blackface	Purebred Blackface	Hill North Country Cheviot
2007	-£0.63	Started in '08	£3.29	£11.42	£3.13	£13.95
2008	£0.44	£20.49	£17.94	£7.37	£17.93	£7.97
2009	£18.37	£32.04	£14.68	£15.92	£1.06	£21.93
2010	£6.00	£4.53	Trial end '09	£5.91	Trial end '09	£5.03
Overall Returns	£24.18	£57.06	£35.91	£40.62	£22.12	£48.70
Average Return p.a.	**£6.05**	**£19.02**	**£11.97**	**£10.16**	**£7.37**	**£12.18**

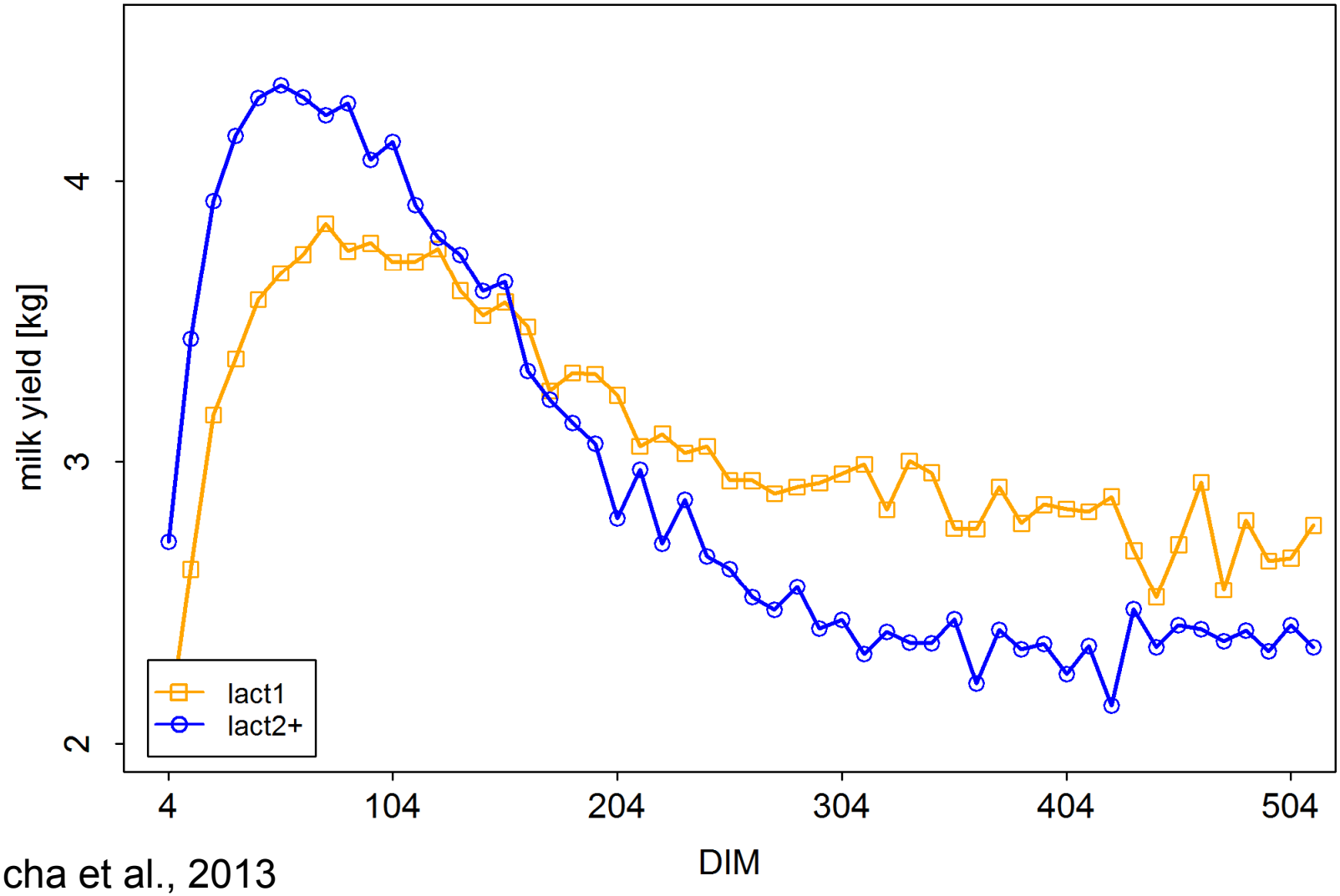
http://www.qmscotland.co.uk/sites/default/files/bbphase2final.pdf

Evidence of benefits
(scientific and in practice)

- ✓ More lambs
- ✓ Heavier lambs
- ✓ More productive ewes
- ✓ ++ £££

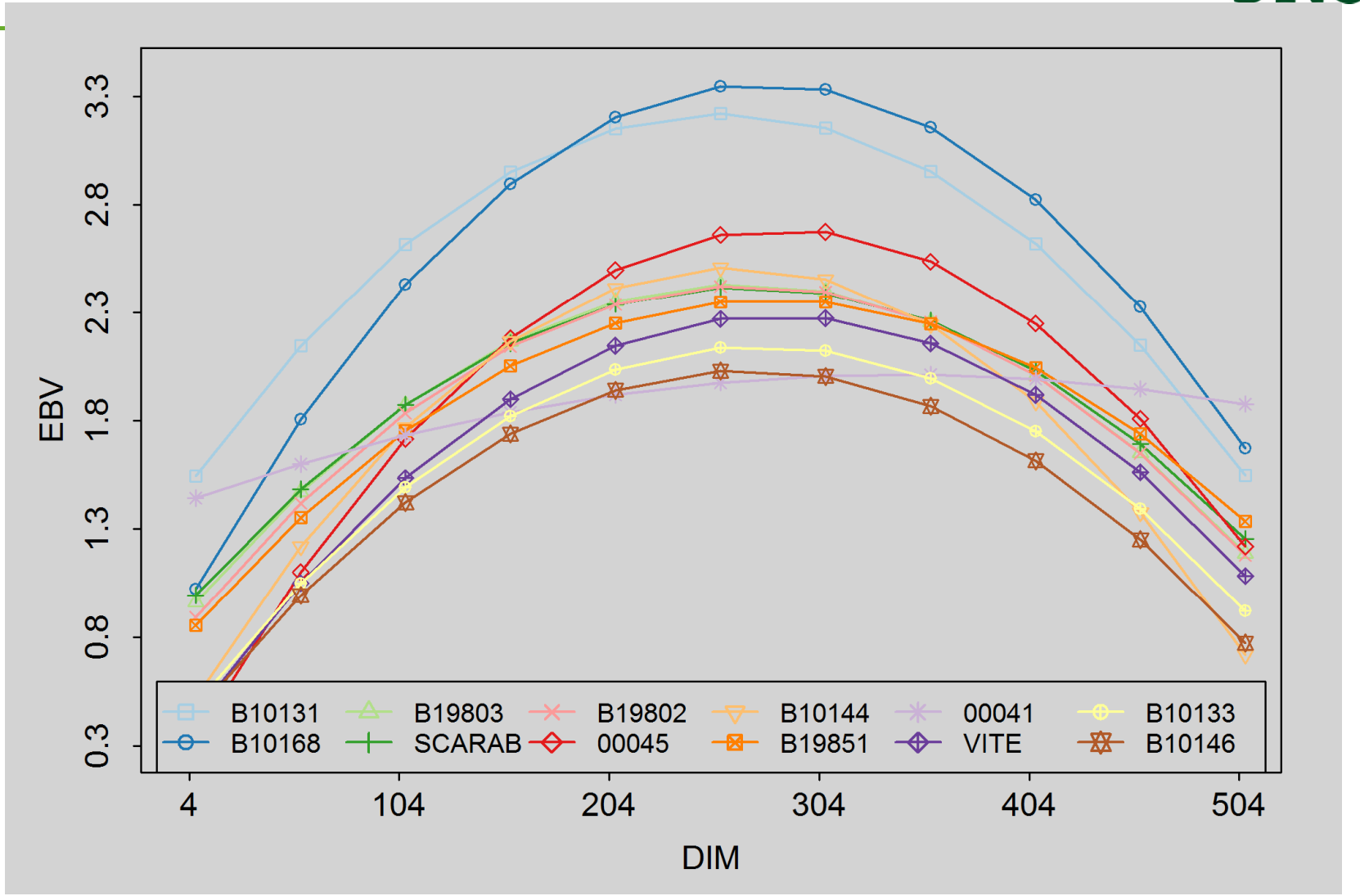
Better flock efficiency!

Goat milk - yield across lactation

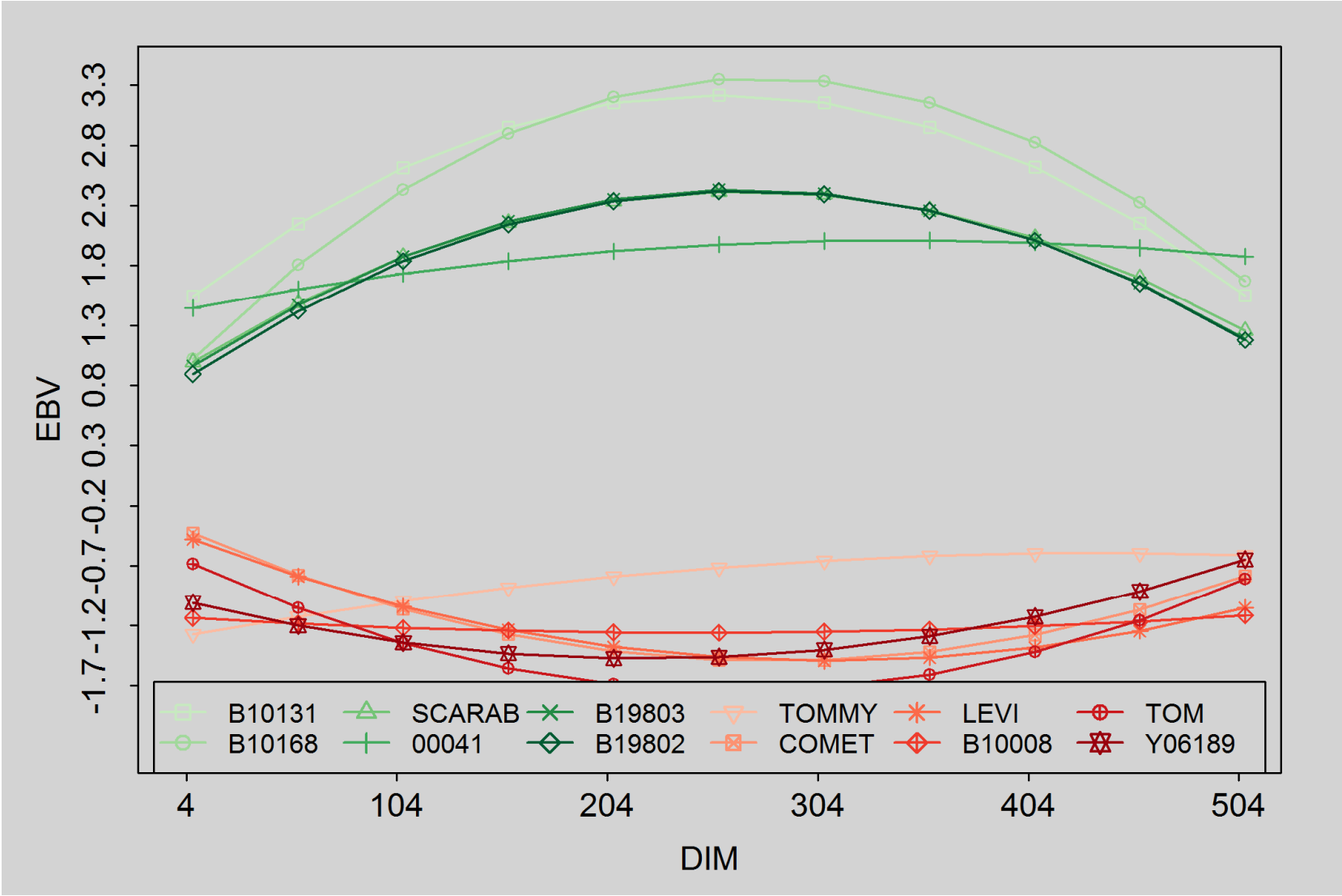


Mucha et al., 2013

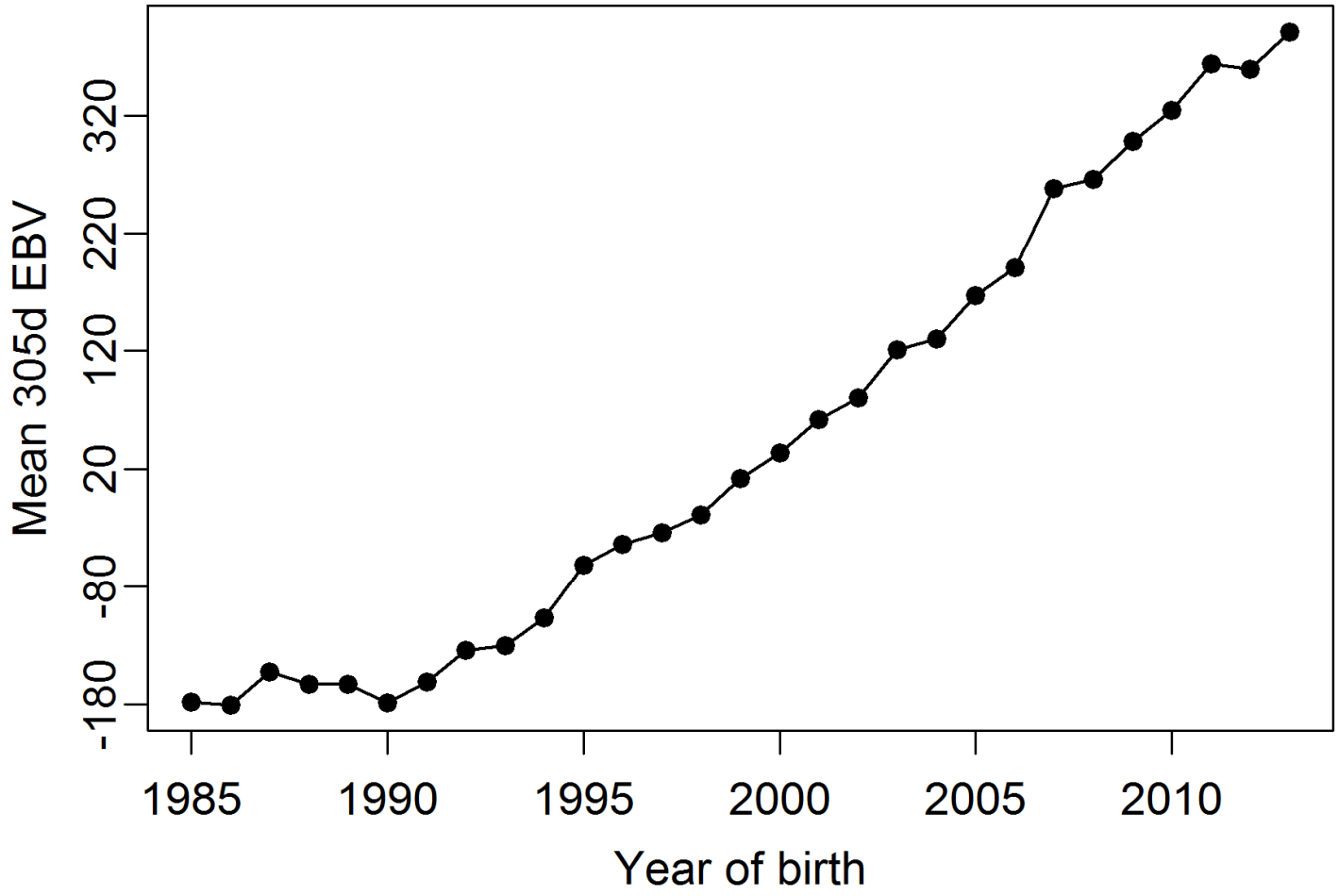
Identification of top sires



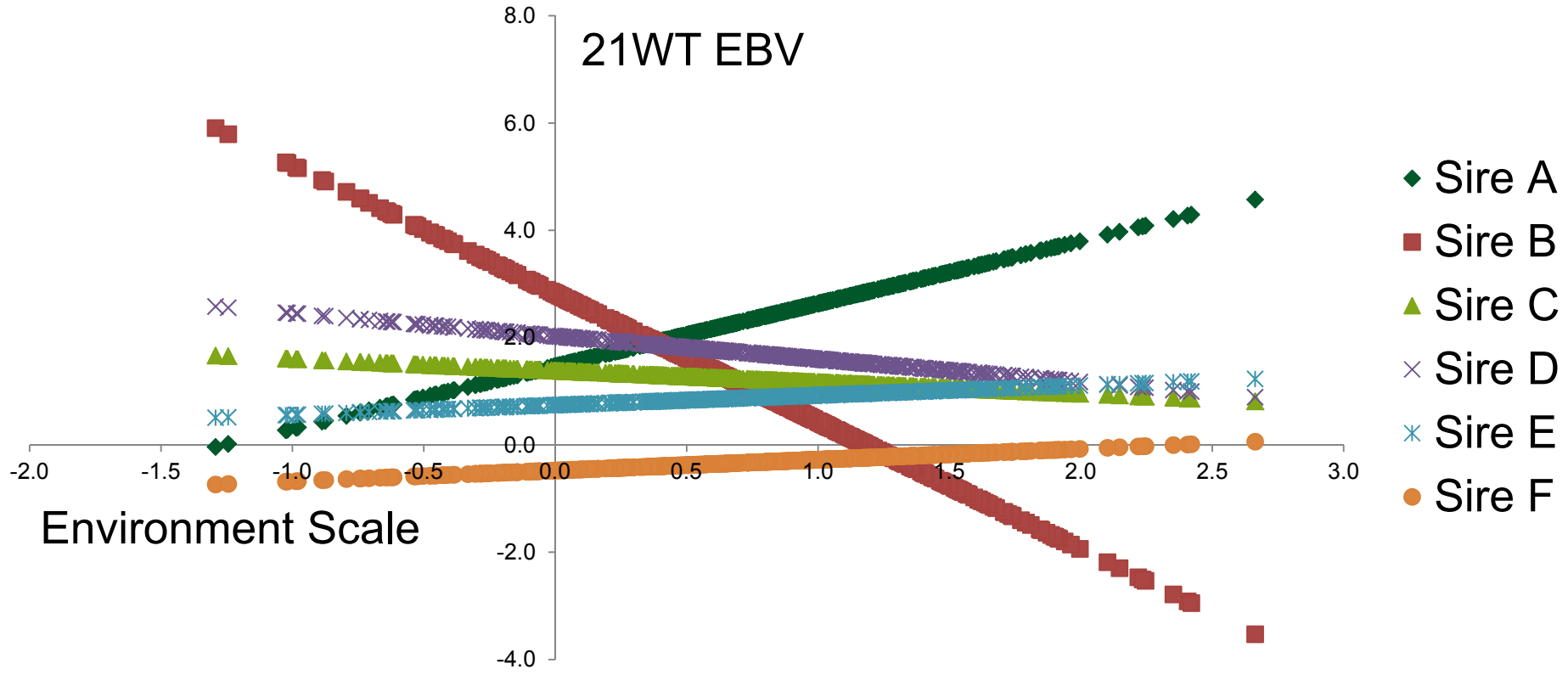
Avoid bottom-ranked sires



Breeding for efficiency – Goat milk yield



Overcoming G x E in sheep?



- Scaling and Re-ranking observed.
- “Robust” sires (E, F) suited to all environments

McLaren et al., *submitted*

Where does genomics fit ?

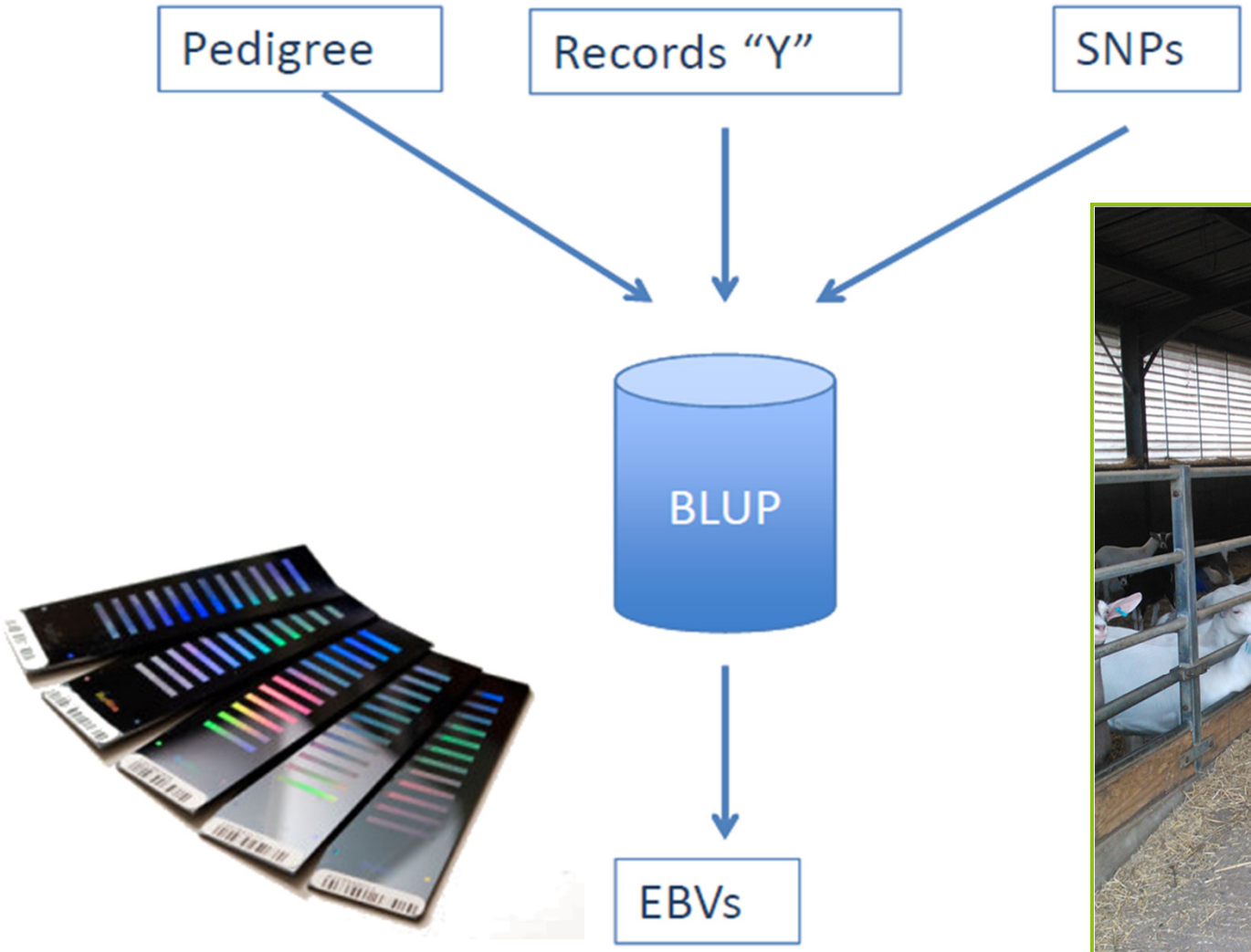
Sheep image courtesy of EBLEX

Genomic selection

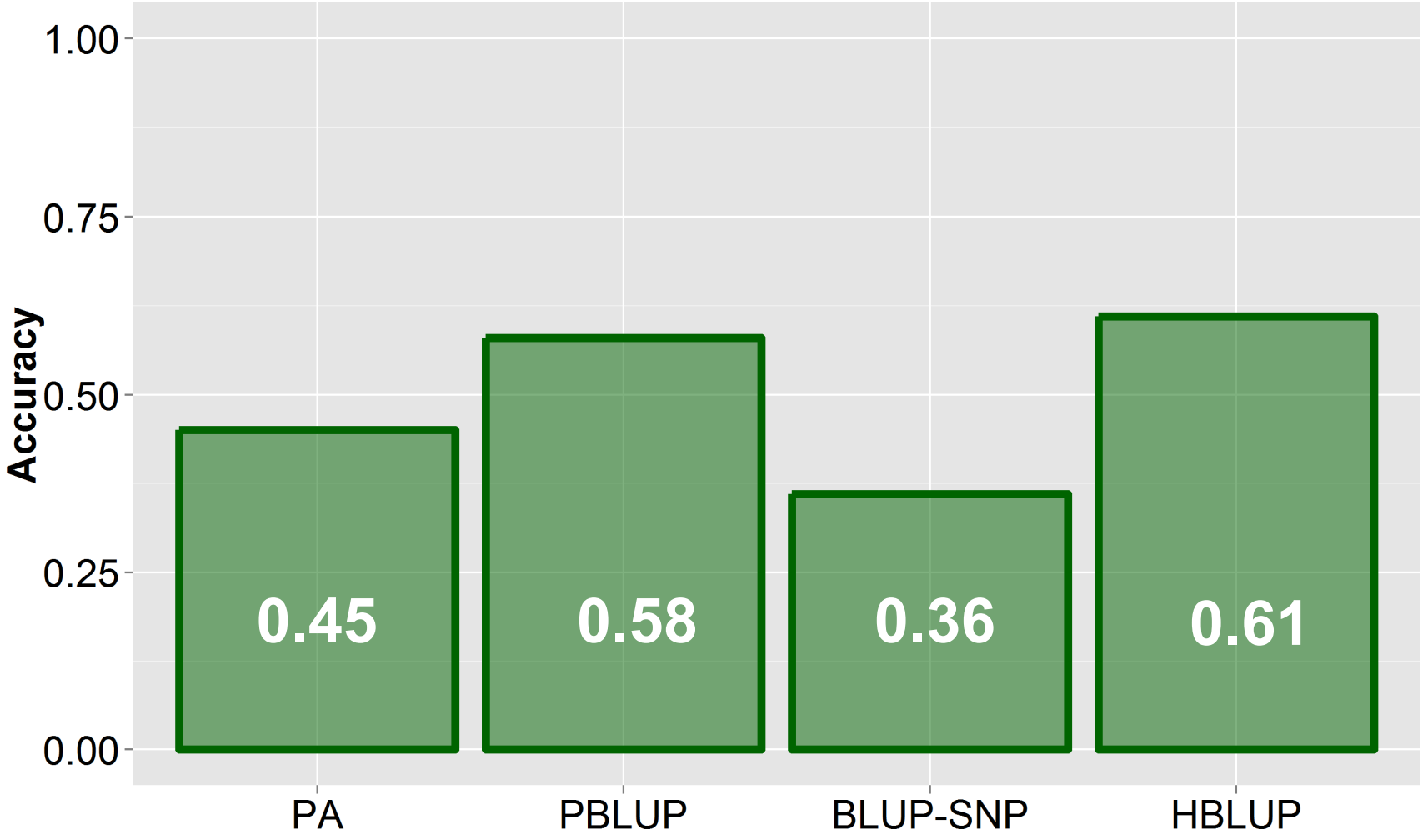
- Using genomics to accelerate genetic improvement and ↑ efficiency
- Dairy sheep & goats
  - Generation interval ↓
  - Accuracy ↑

Mucha et al, 19th WCGALP Vancouver, 2014

Single-Step Genomic Selection



Accuracy of selection – milk yield in dairy goats



Mucha et al, 19th WCGALP Vancouver, 2014

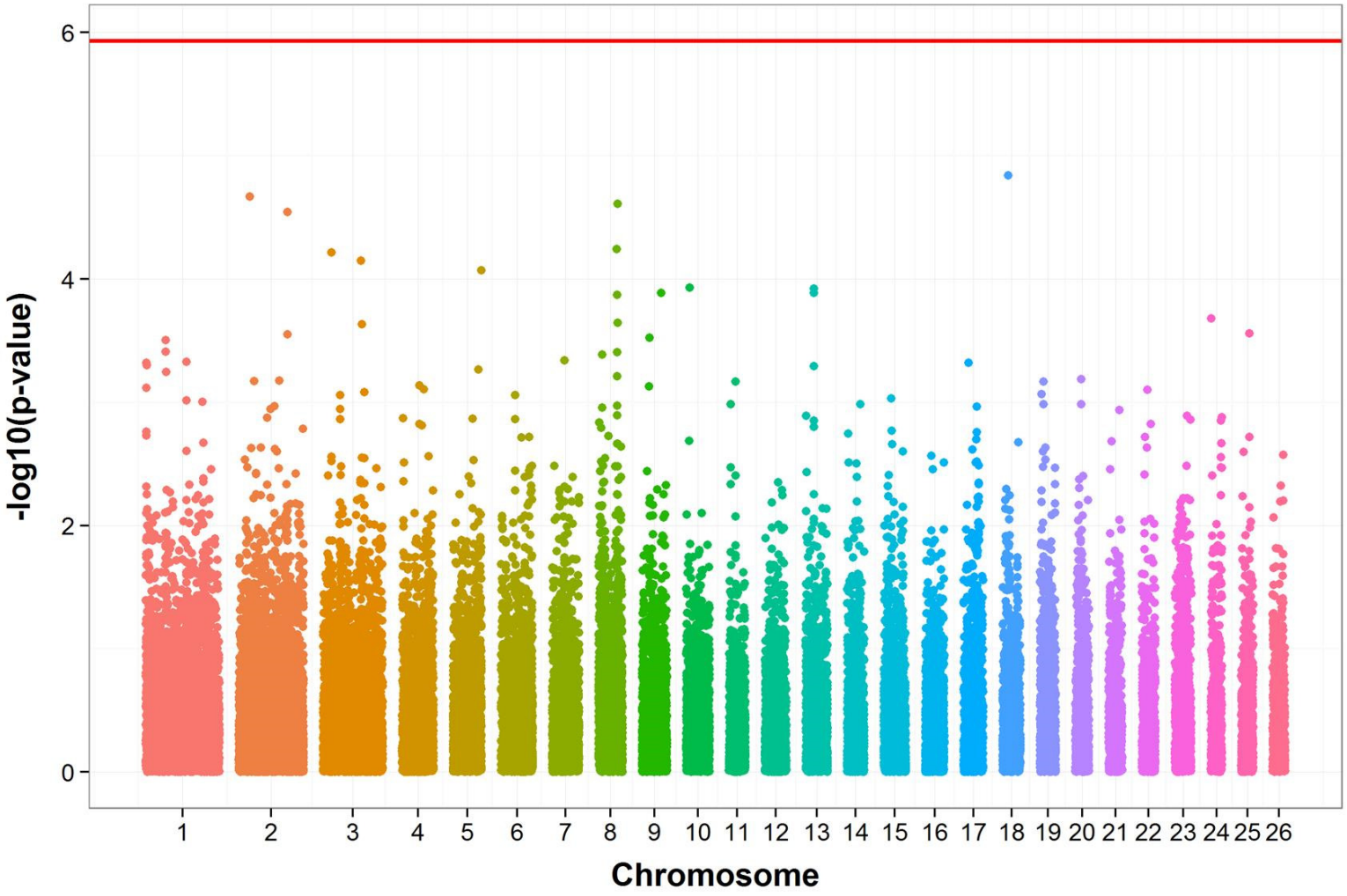
Main efficiency elements affected by breeding

- Quantity of product per offspring/ time period
- Disease resistance
- Quality of product
- Body weight of breeding female
- Growth rate of offspring
- Efficiency of food conversion

Using genomic selection for disease resistance

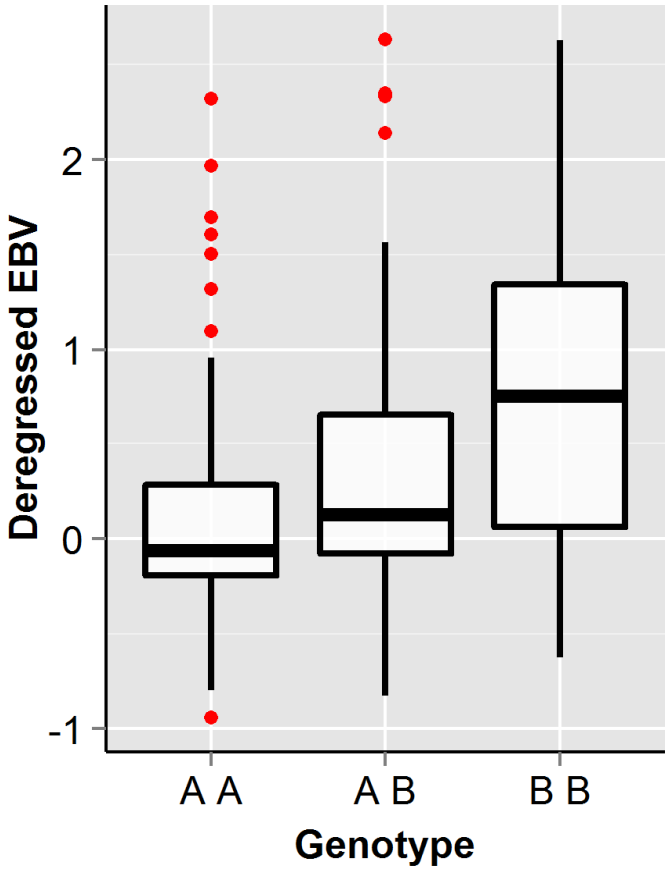
‘Managing’ the problems of disease - lameness

Genome-wide association
FOOTROT in sheep



Mucha, Bunger, Conington *submitted*.

SNP genotype differences for Footrot



Example of SNP OAR2_198741802.1

Main efficiency elements affected by breeding

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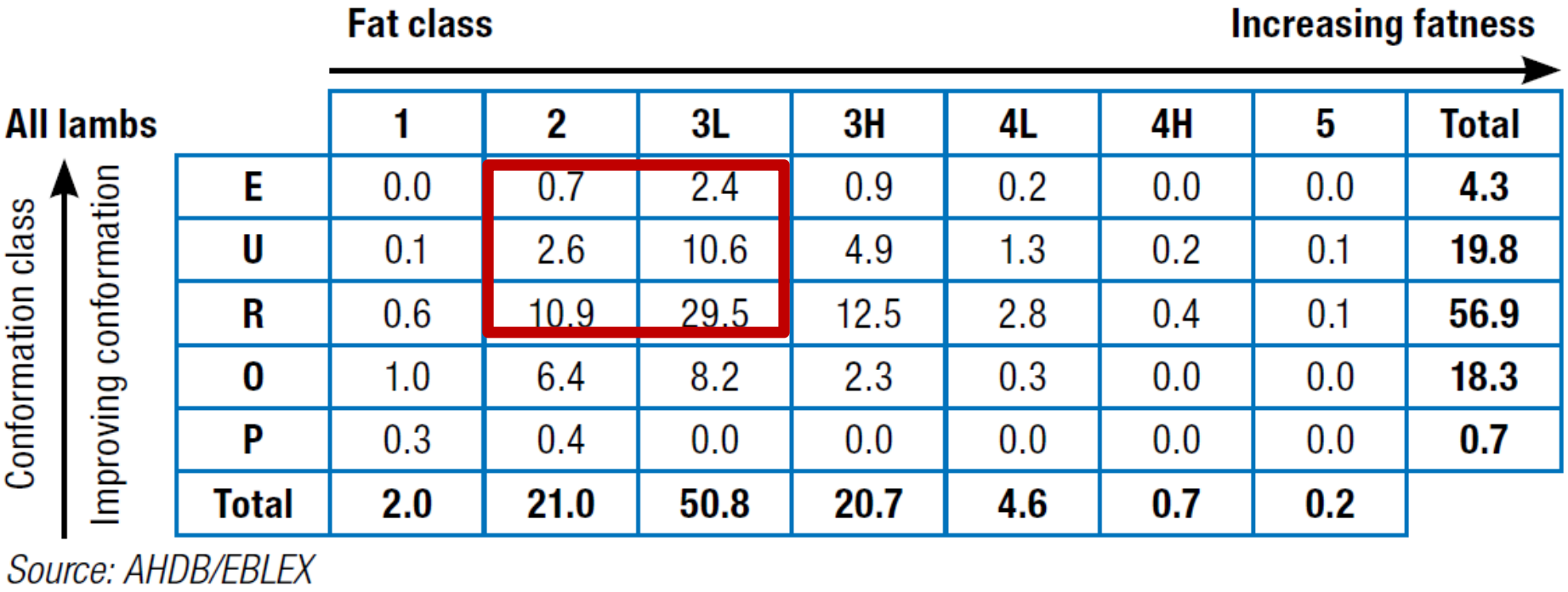
EUROP lamb grading system



Fat class → Increasing fatness

All lambs	1	2	3L	3H	4L	4H	5	Total
E	0.0	0.7	2.4	0.9	0.2	0.0	0.0	**4.3**
U	0.1	2.6	10.6	4.9	1.3	0.2	0.1	**19.8**
R	0.6	10.9	29.5	12.5	2.8	0.4	0.1	**56.9**
O	1.0	6.4	8.2	2.3	0.3	0.0	0.0	**18.3**
P	0.3	0.4	0.0	0.0	0.0	0.0	0.0	**0.7**
Total	**2.0**	**21.0**	**50.8**	**20.7**	**4.6**	**0.7**	**0.2**	

Conformation class — Improving conformation

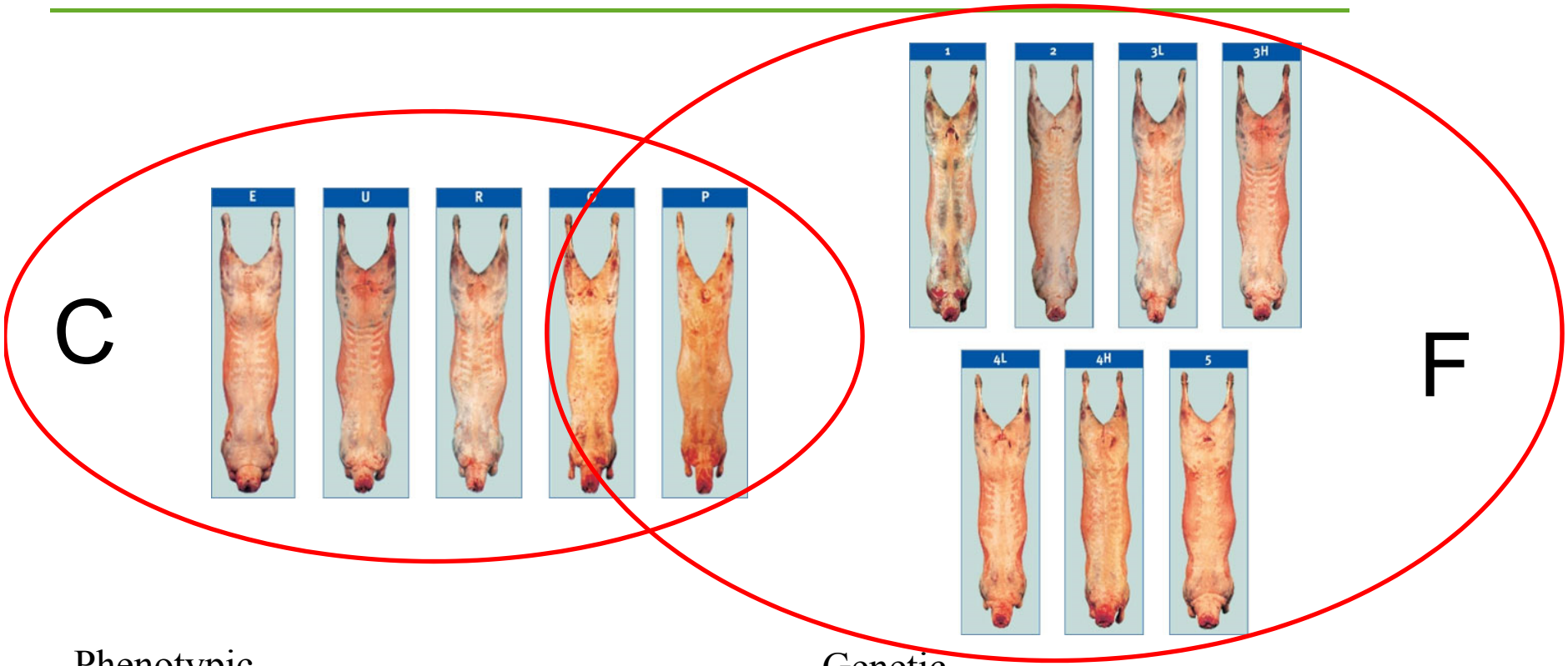
Source: AHDB/EBLEX

% distribution lamb carcasses 2012

Current subjective grading to estimate carcass value

Problem = Only ~56% of UK lambs meet target specification

Conformation (C) score confounded with fatness (F)



Phenotypic
MLCC: MLCF r = 0.32
MLCC: ESTF r = 0.35
MLCC: KKCF r = 0.25

Genetic
MLCC: MLCF r = 0.37
MLCC: ESTF r = 0.19
MLCC: KKCF r = 0.45

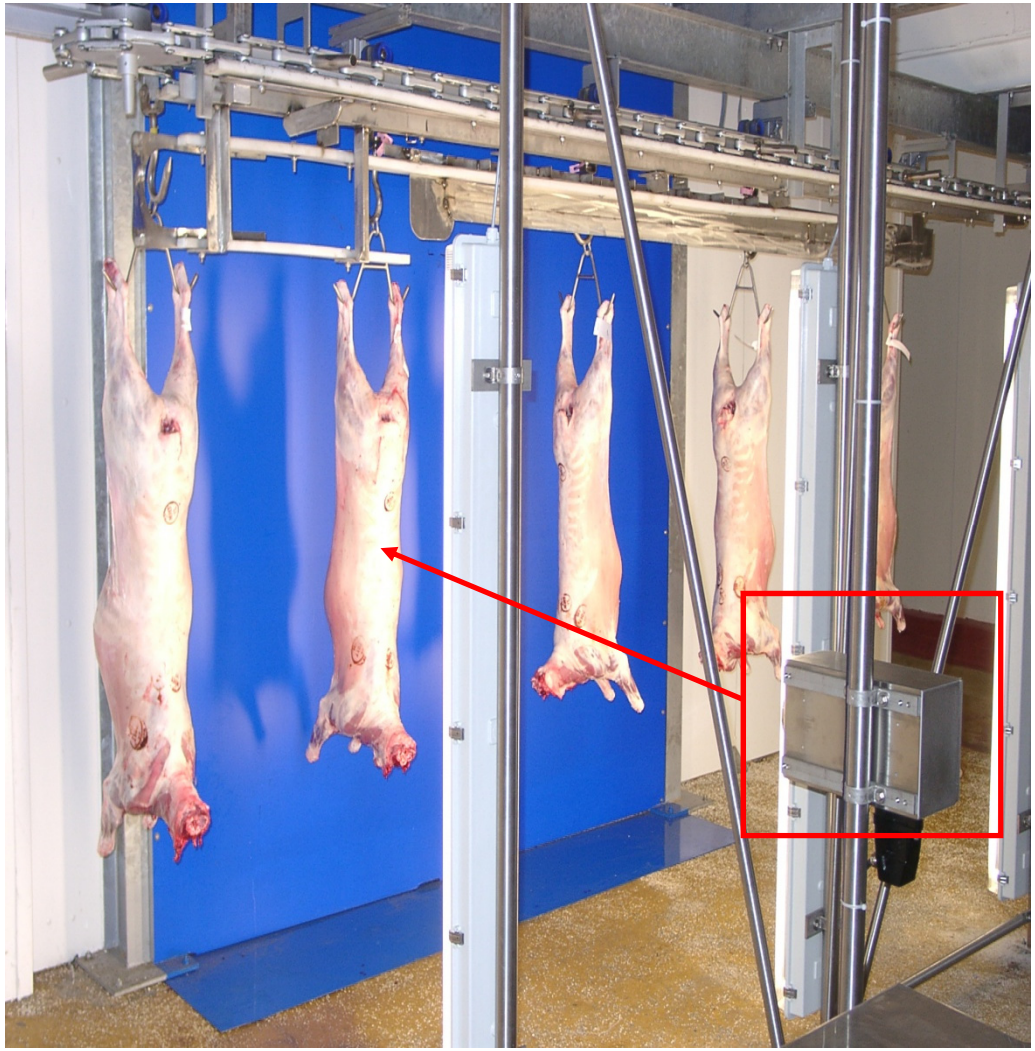
Need a predictor of muscling / lean meat yield independent of fatness

Jones et al., 1999. Anim Sci **69** 553-561

VIA can replace outdated subjective method with accurate objective one

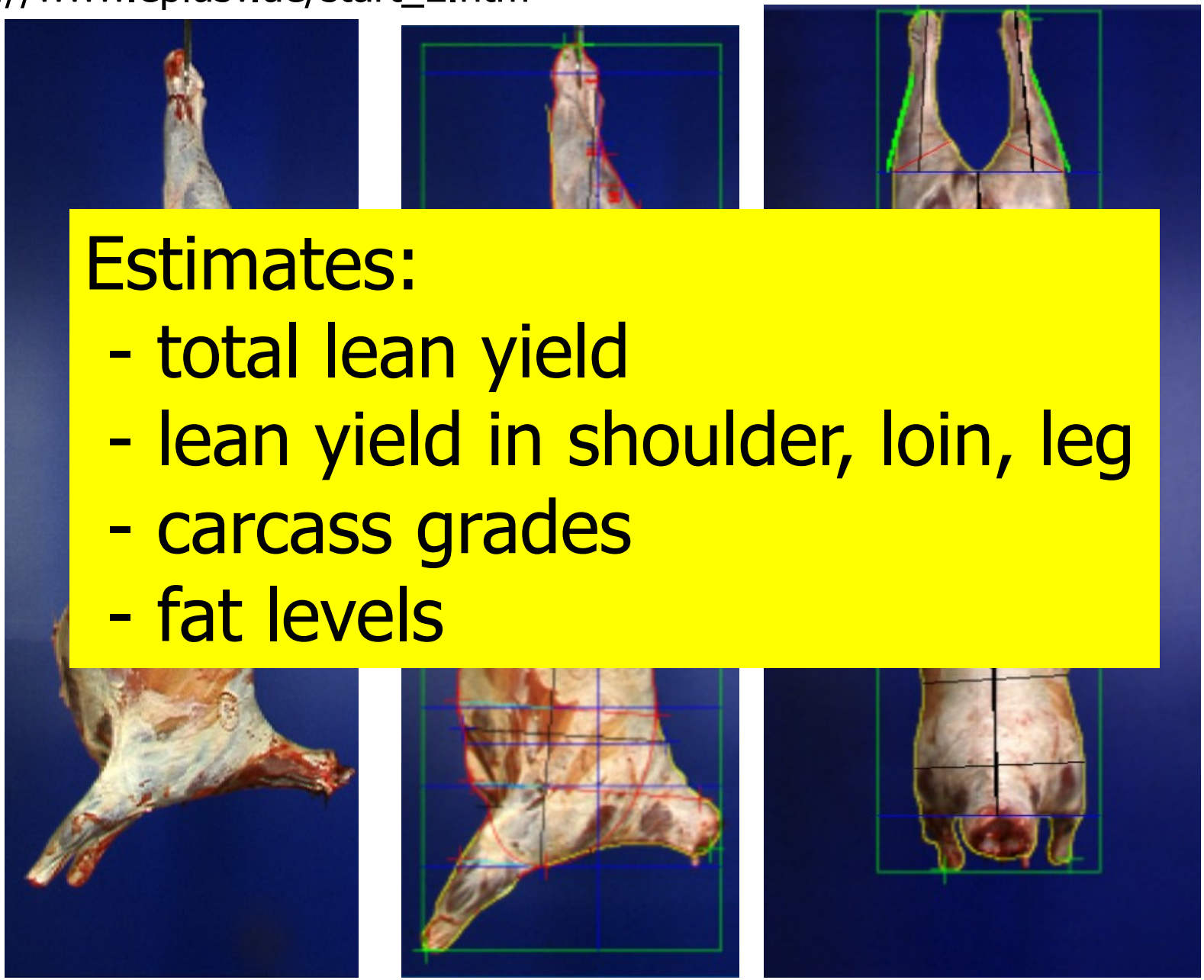
- Online integration into the slaughter line
  - Performance: 800 / hour

- Automatically captures data on:
  - widths
  - areas
  - angles
  - colours



VIA: VSS 2000 Automatic grading and classification of sheep and lamb

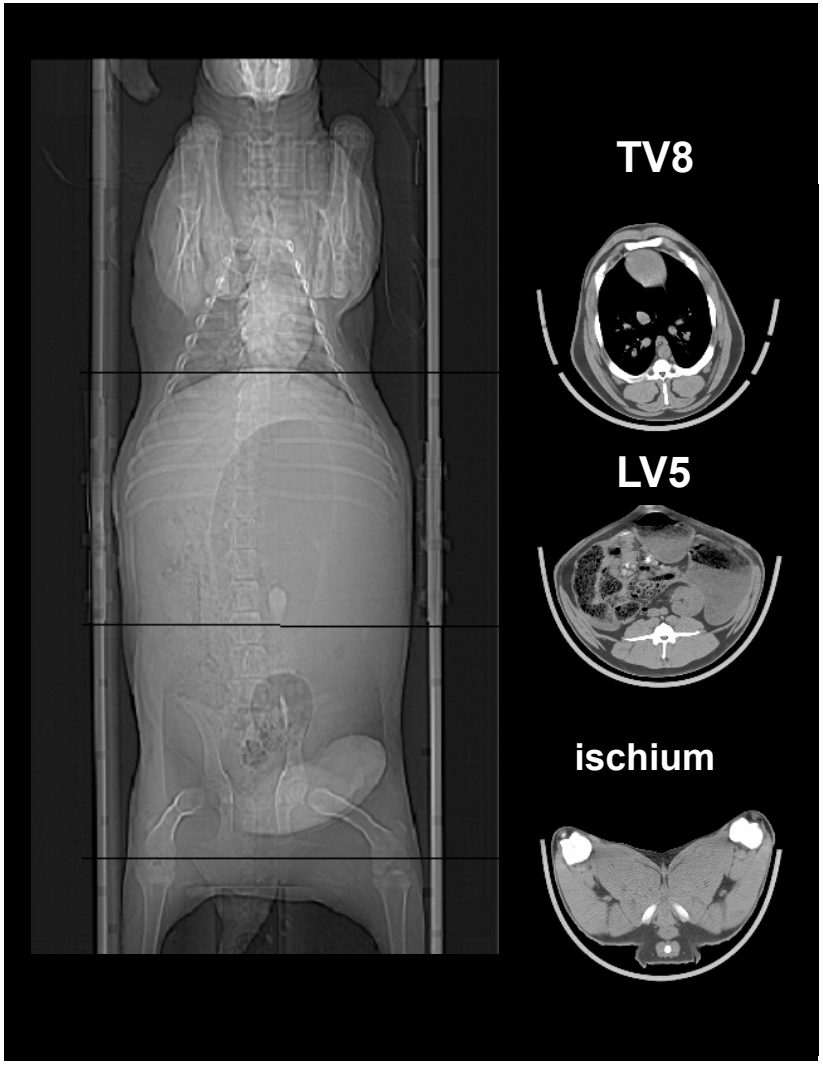
http://www.eplusv.de/start_E.htm



Estimates:

- total lean yield
- lean yield in shoulder, loin, leg
- carcass grades
- fat levels

Live predictions of carcass merit in UK sheep breeding - X-ray Computer Tomography (CT)



8th rib vertebra (TV8)

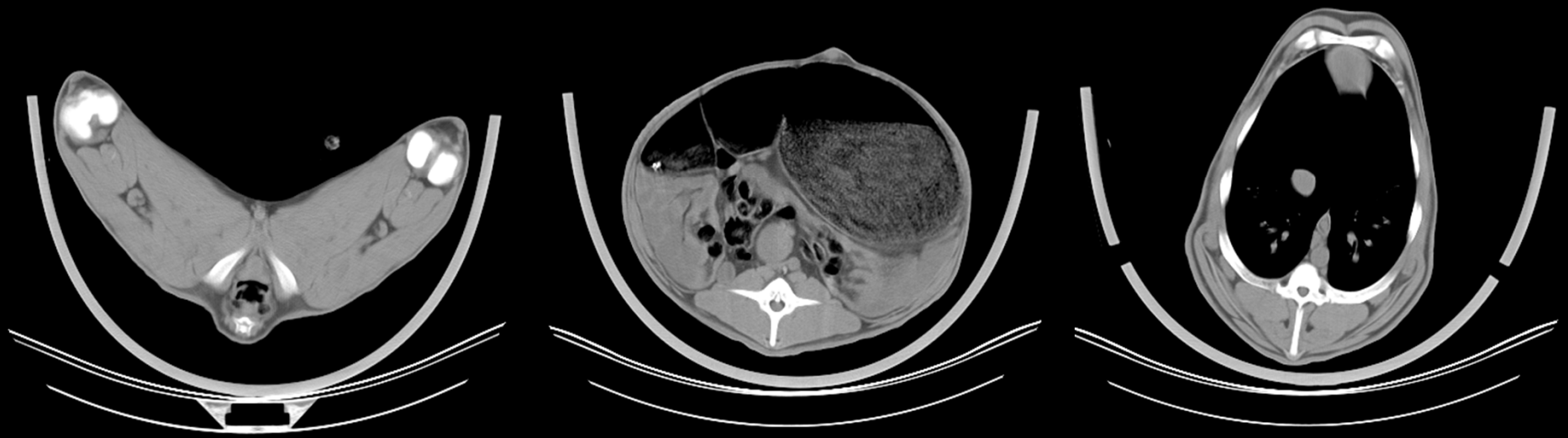
5th lumbar vertebra (LV5)

Back of the pelvis (ischium)

Accurate *in vivo* estimates of body composition

	R^2
muscle	92%
fat	96%
bone	81%

Example of ‘poor’ lamb 36.7 kg



Example of ‘good’ lamb 36.4 kg

Traceability facilitates breeding and management e.g. EID

- Sheep - electronic tagging for all animals born after the 31st December 2009

- EID is a radio frequency microchip that can be embedded in an eartag or bolus and read by handheld or fixed reading equipment.

- Traceability, movements

EID

SRUC

EID readers

Electronic weighing system

- chip in ear tag/ bolus
- can shed automatically on weight, wt change, breed, group, ID list etc

Load cells beneath or suspension from above

Attached to digital display

Automatic drafting gates attached

Benefits of Electronic Identification (EID)

- Minimise labour
  - weighing, shedding / drafting
- Traceability
- Identify animals for specific management
  - Anthelmintics administered acc. deviation in expected liveweight change
  - Lambs target weight for slaughter
  - Individual treatments
  - Feeding groups

Targeted Selective Treatment
EID + worming = TST = ££€€

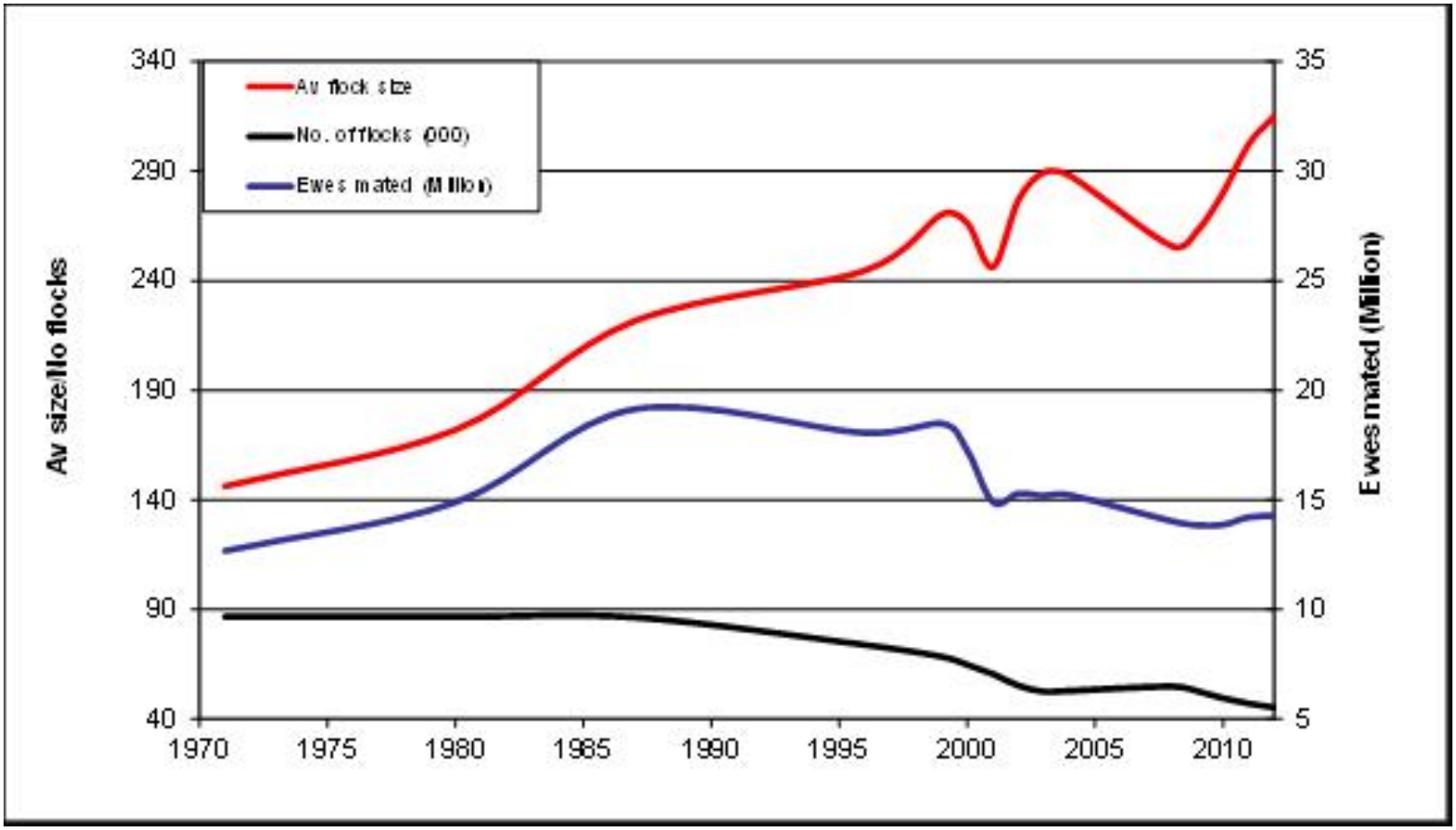
- Refugia-based worming method:
  - **Aim** – to slow down rate of increase in resistance to anthelmintics
  - only a proportion of the flock is treated at any one time to maintain an anthelmintic-susceptible parasite population (*Kenyon et al, 2009; Kenyon et al, 2013*).
  - The ability to effectively **target** anthelmintic use relies on the **identification of those animals** that will most benefit from treatment using short-term **weight change**.

Getting it all right!

- Breeding
- Livestock system
- Feeding
- Disease
- Labour use*

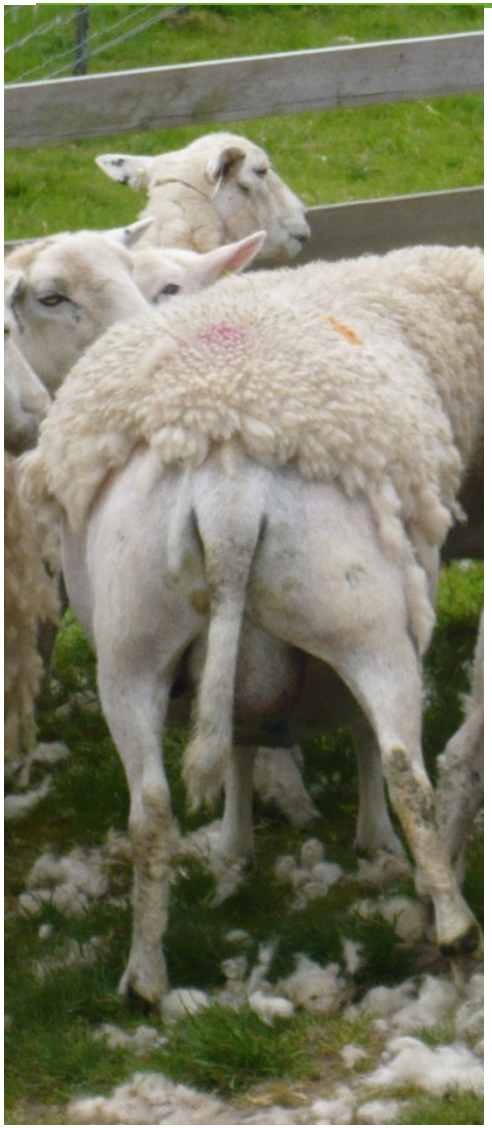
- & post-farm considerations
  - E.g. Target market

Flock sizes are increasing
No. Flocks declining



Pollot, 2014 *unpublished results*

Natural wool-shedding sheep



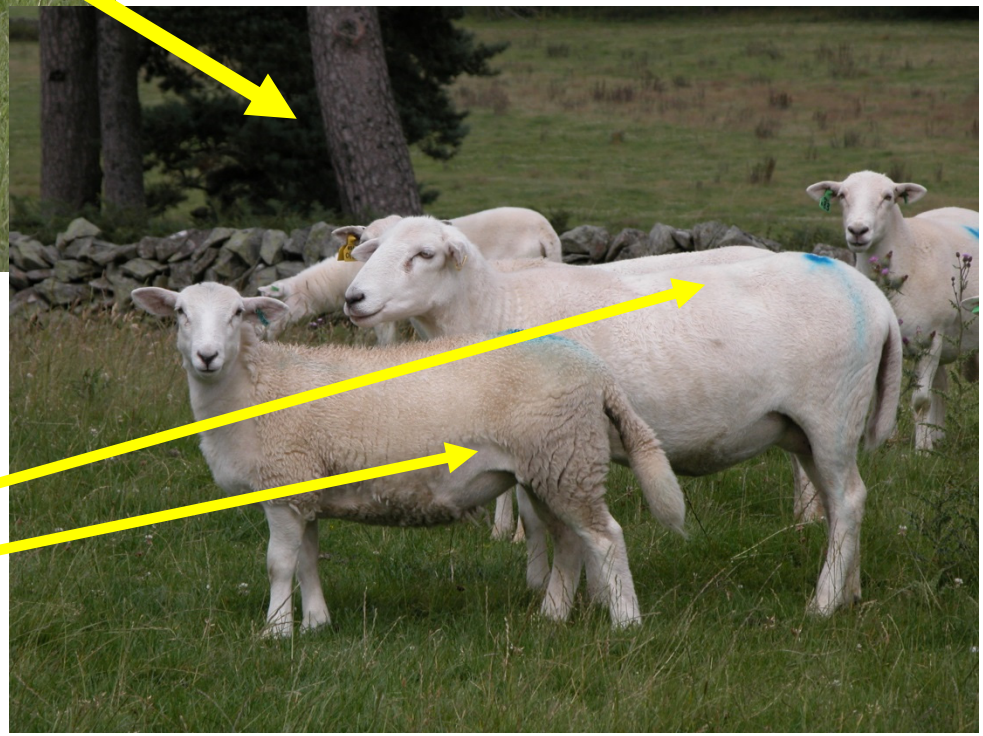
Wiltshire Horn

‘Easycare’ (polled)

(= Welsh Mt, Cheviot, Wilt. Horn)

Breeding away the problem of parasites – wool shedding

Shedding wool in Spring (May)

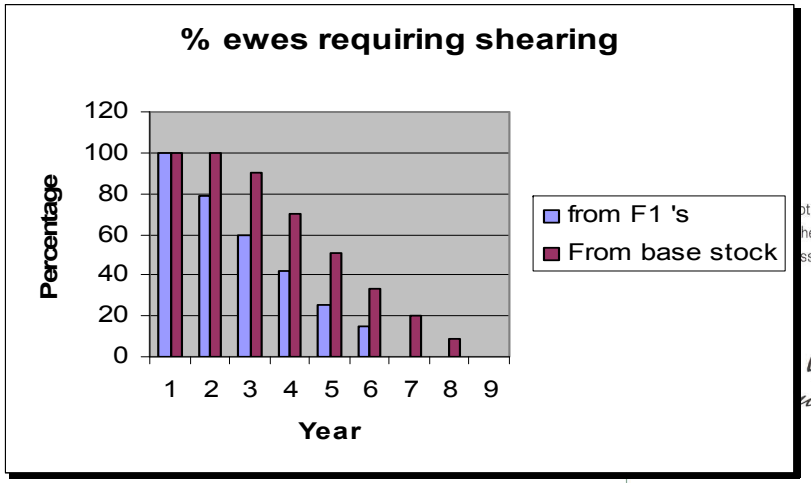


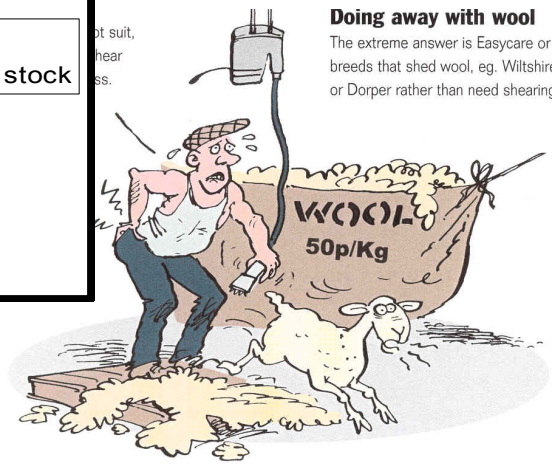
August

- Ewe shedding complete
- Lamb shedding coat

Benefits

- No shearing
- No ‘dagging’
- No ‘belly wool’
- Clean tails – reduced fly strike incidence
- Fewer ‘backed’ ewes (from heavy fleeces)
- Low levels of assistance at lambing





Conclusions

- Europe alone unlikely to have ‘big’ world impact

However

- Being more efficient
  - Use of high genetic merit & DEMONSTRATING

- Smart use of labour & new technology

- ‘Whole chain’ payment system linked to quality

Acknowledgements

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The Scottish Government

defra
Department for Environment Food and Rural Affairs

Signet

Technology Strategy Board
Driving Innovation

EBLEX

awin
ANIMAL WELFARE INDICATORS

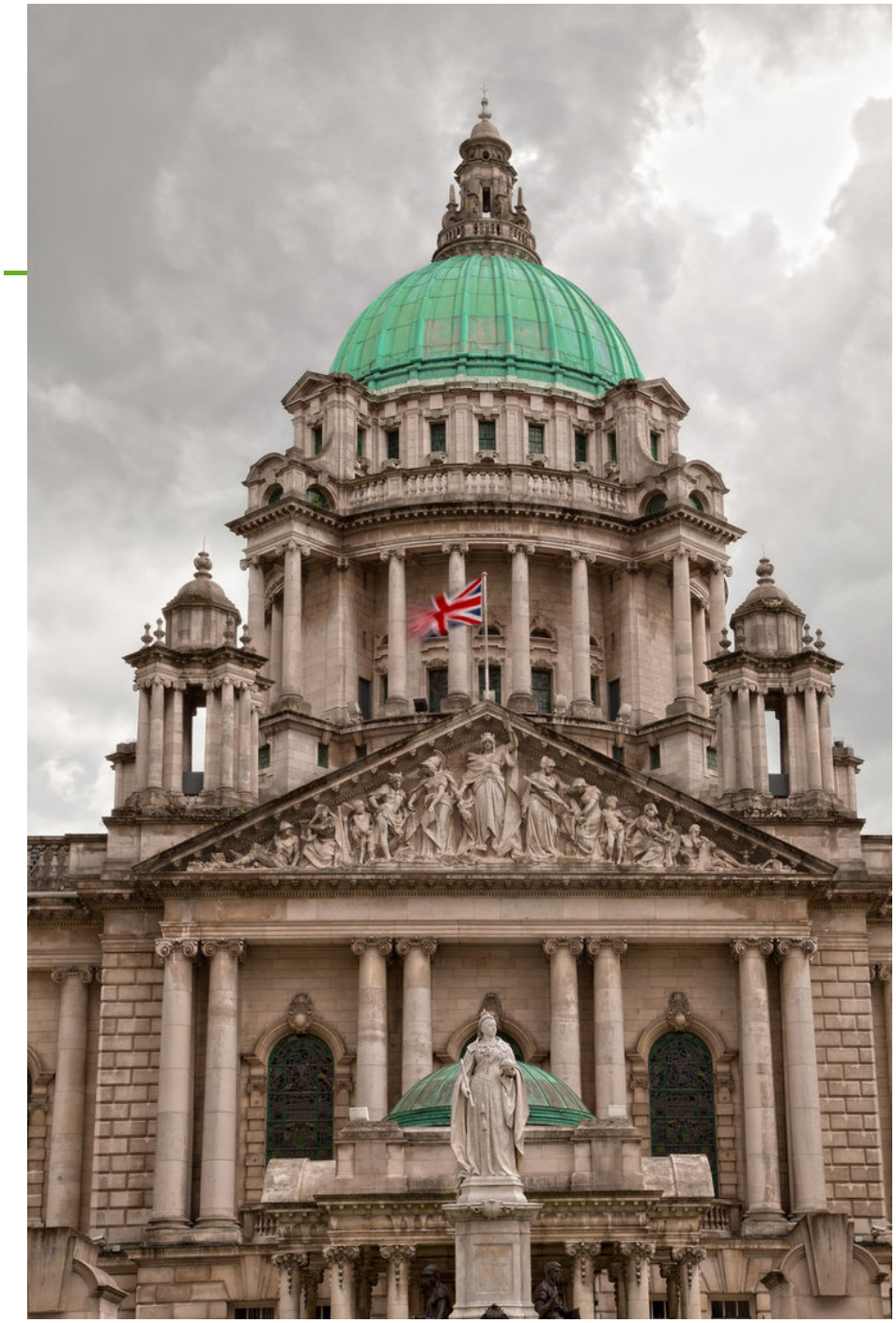
EAAP 2016

European Federation of Animal Science Annual Meeting – Livestock Systems and Science

Belfast

28 August–1 Sept 2016

www.eaap2016.org



Thank you for listening!

Photo courtesy of Ann & Sandy Welsh

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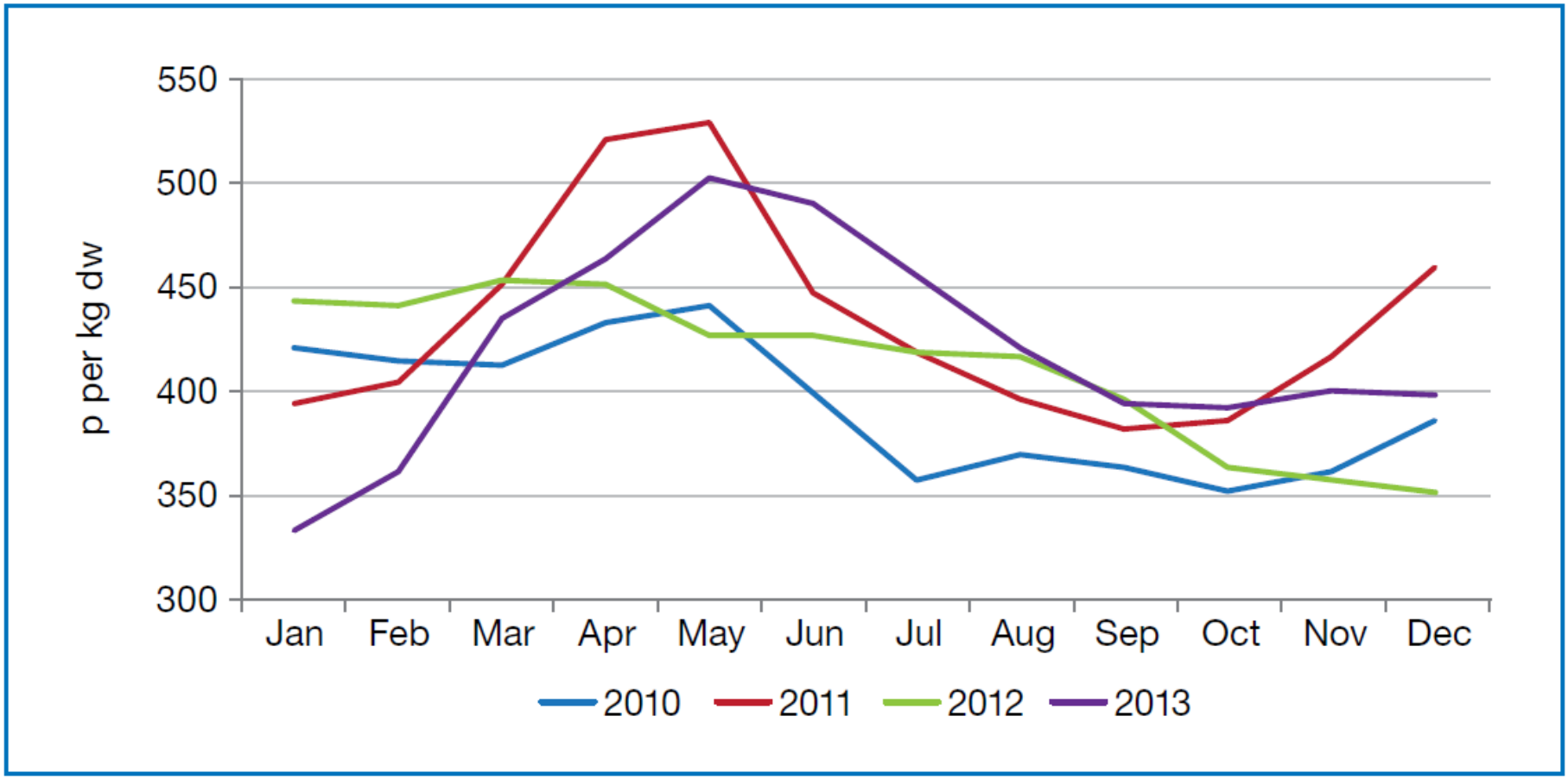
Leading the way in Agriculture and Rural Research, Education and Consulting

Seasonality of lamb prices UK 2010-2013

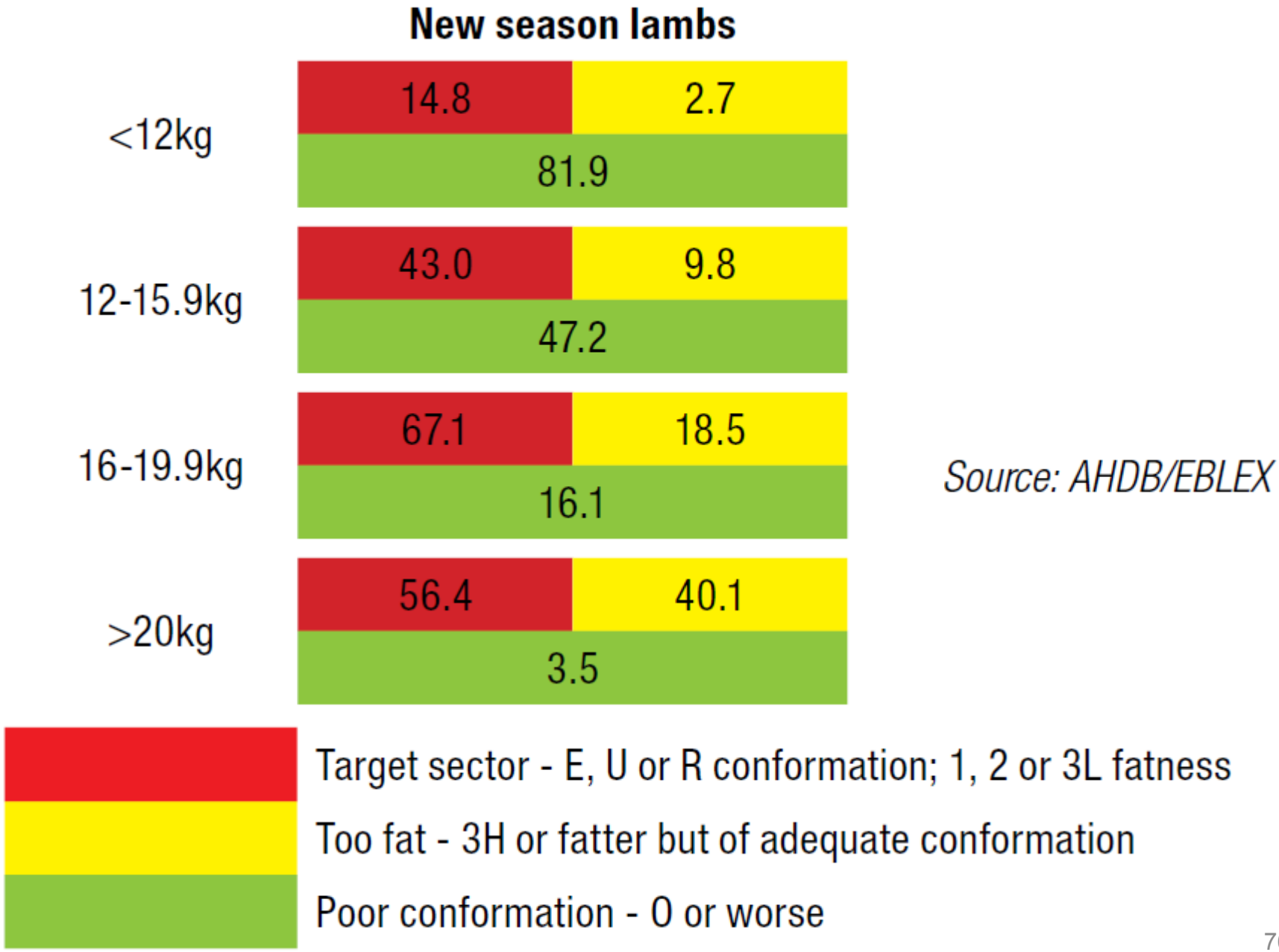


- Intensive system: 2 -> 9 litres day; BF @ approx. 3.5 -> 4%; Prot 2.5 -> 3.5%
- Extensive/grazing: 1.5 - > 4 litres day; BF @ approx. 4 -> 5.5%; Prot 3 -> 4.5%

Calculating weight change?

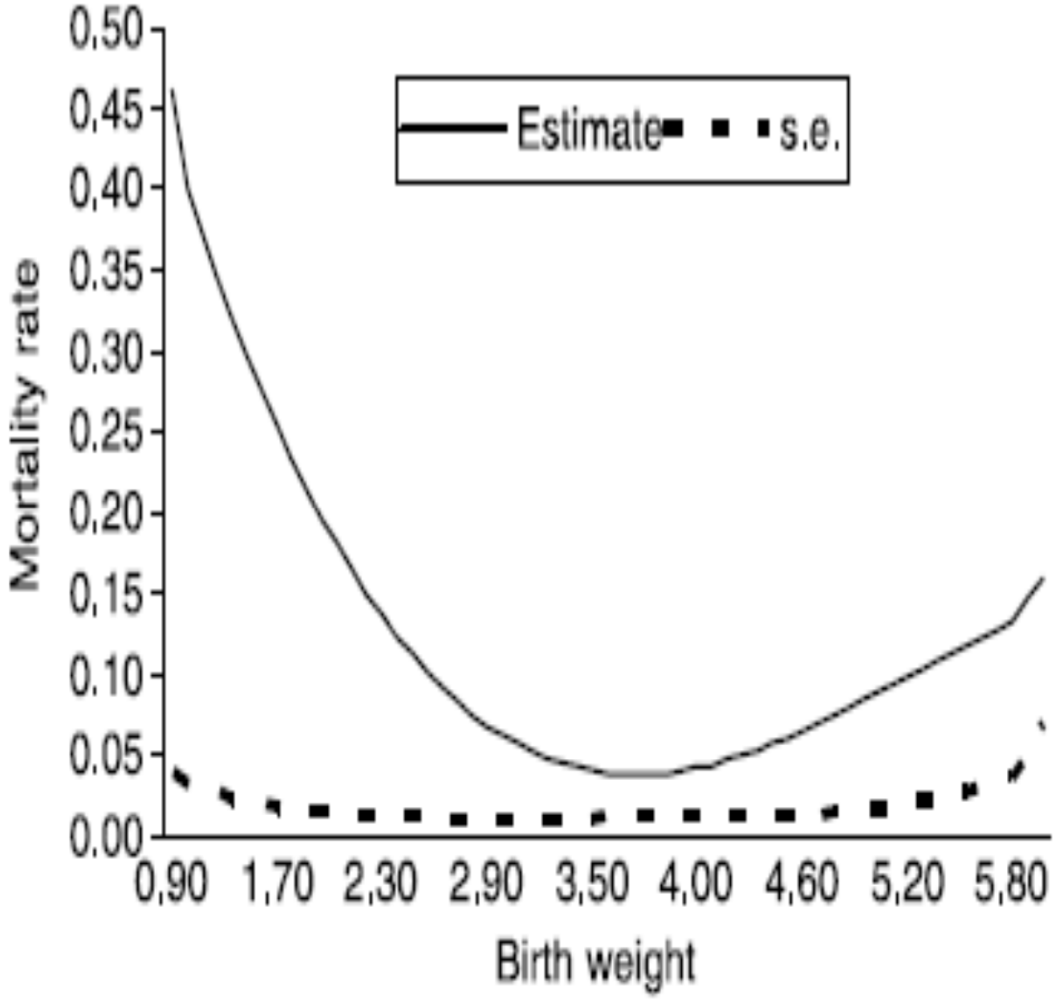
- Algorithm developed by Moredun RI and Lincoln University
  - Animal weight and the expected feed intake to predict expected live weight
  - Pasture Measurements to establish biomass availability

- Based on weight *change*
  - Algorithm calculates predicted lamb weights
  - Above predicted weight: no treatment
  - Below predicted weight: treatment based on size

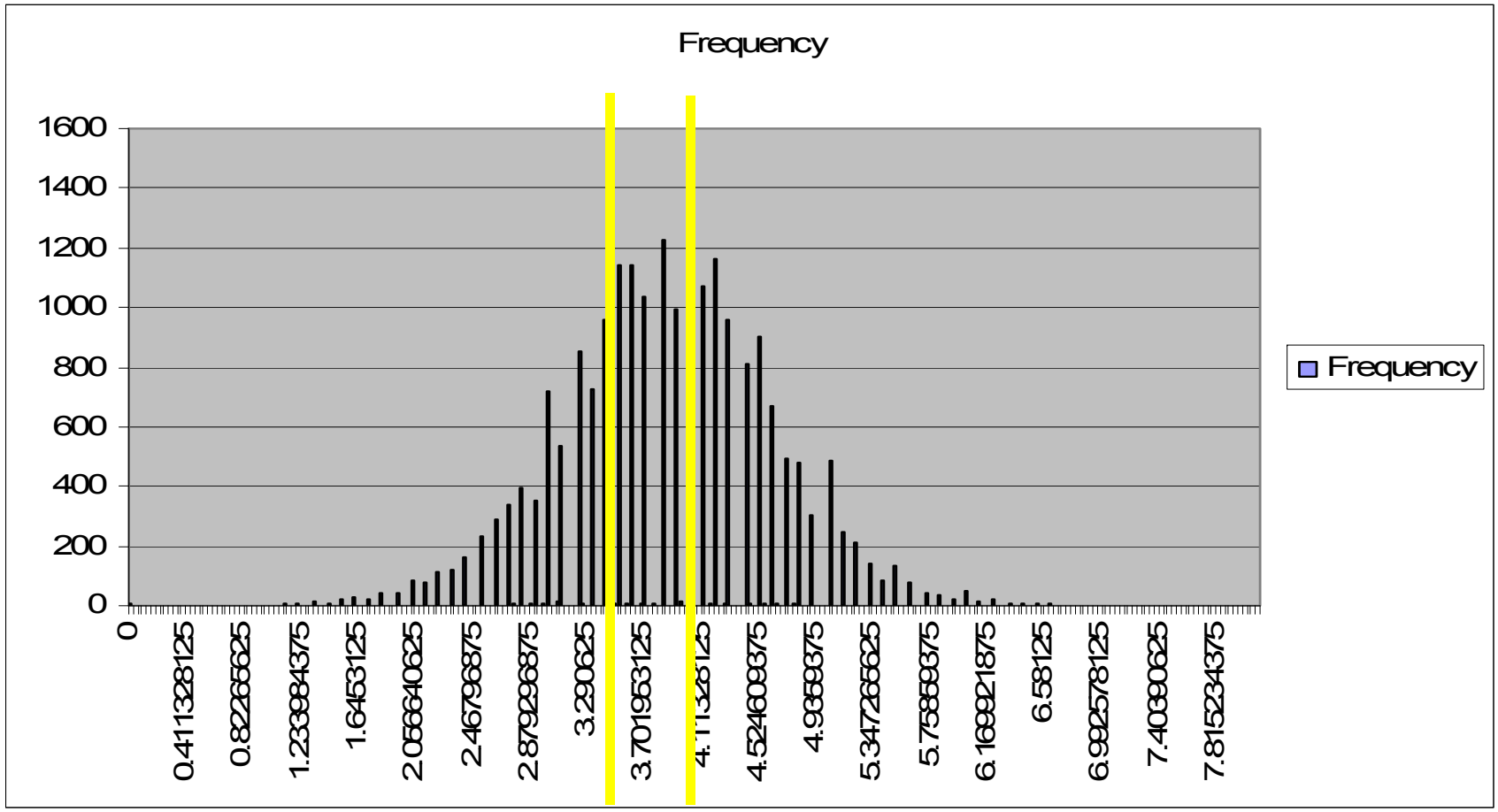


Source: AHDB/EBLEX

Relationship of mortality rate & birth weight



(Sawalha, Conington, Brotherstone, Villanueva 2007 Animal 1: 151-157)



Lambs born with live weights between 3.5 and 4 kg had lower mortality rates than lighter or heavier lambs

Sheep density map – 2005 *(census data)*

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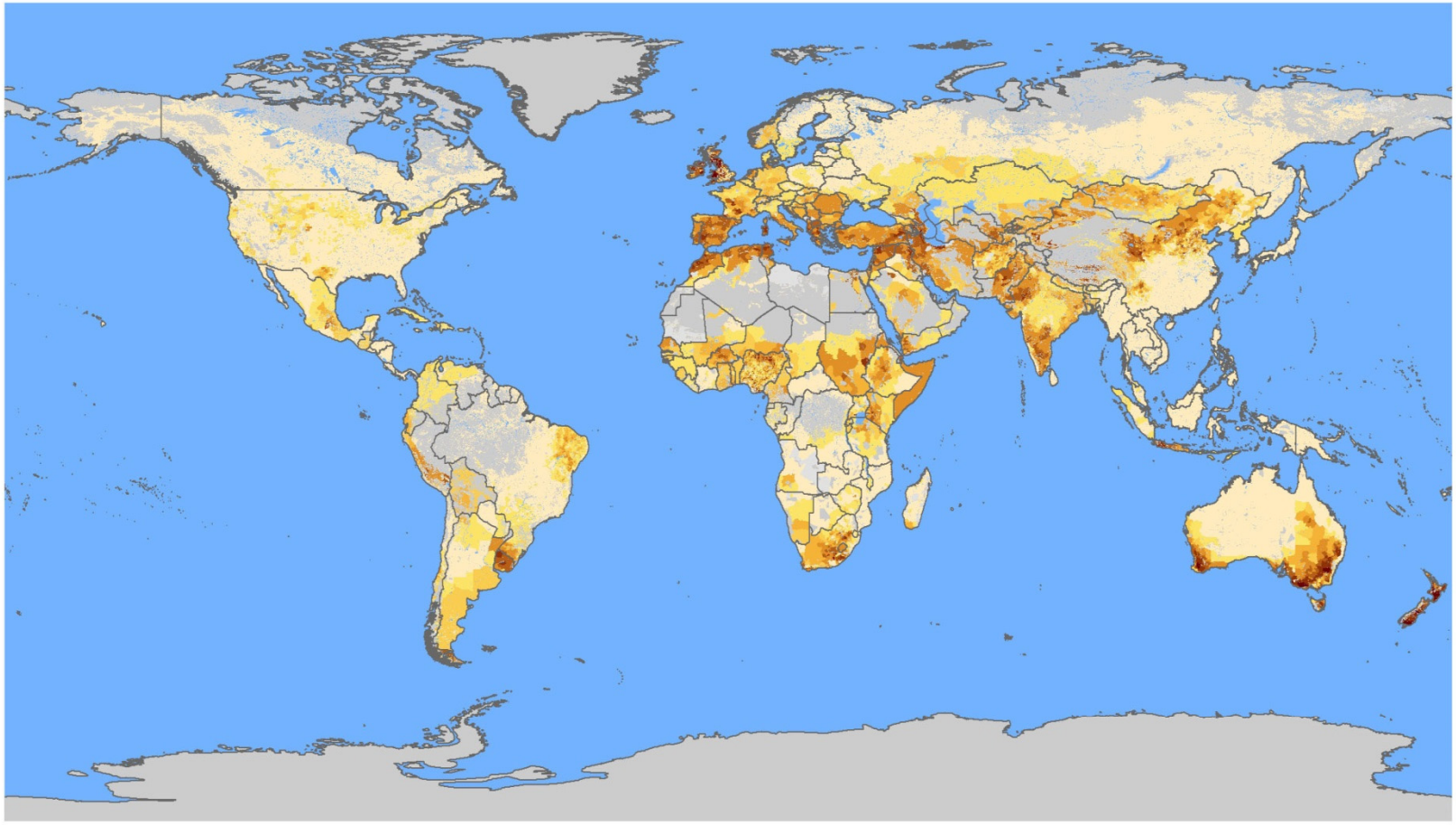
Animal Production and Health Division



Number per square km

<1	5–10	20–50	100–250	Water	No data
1–5	10–20	50–100	>250	Unsuitable for ruminat	

Source: Gridded Livestock of the World

Goats density map – 2005 *(census data)*

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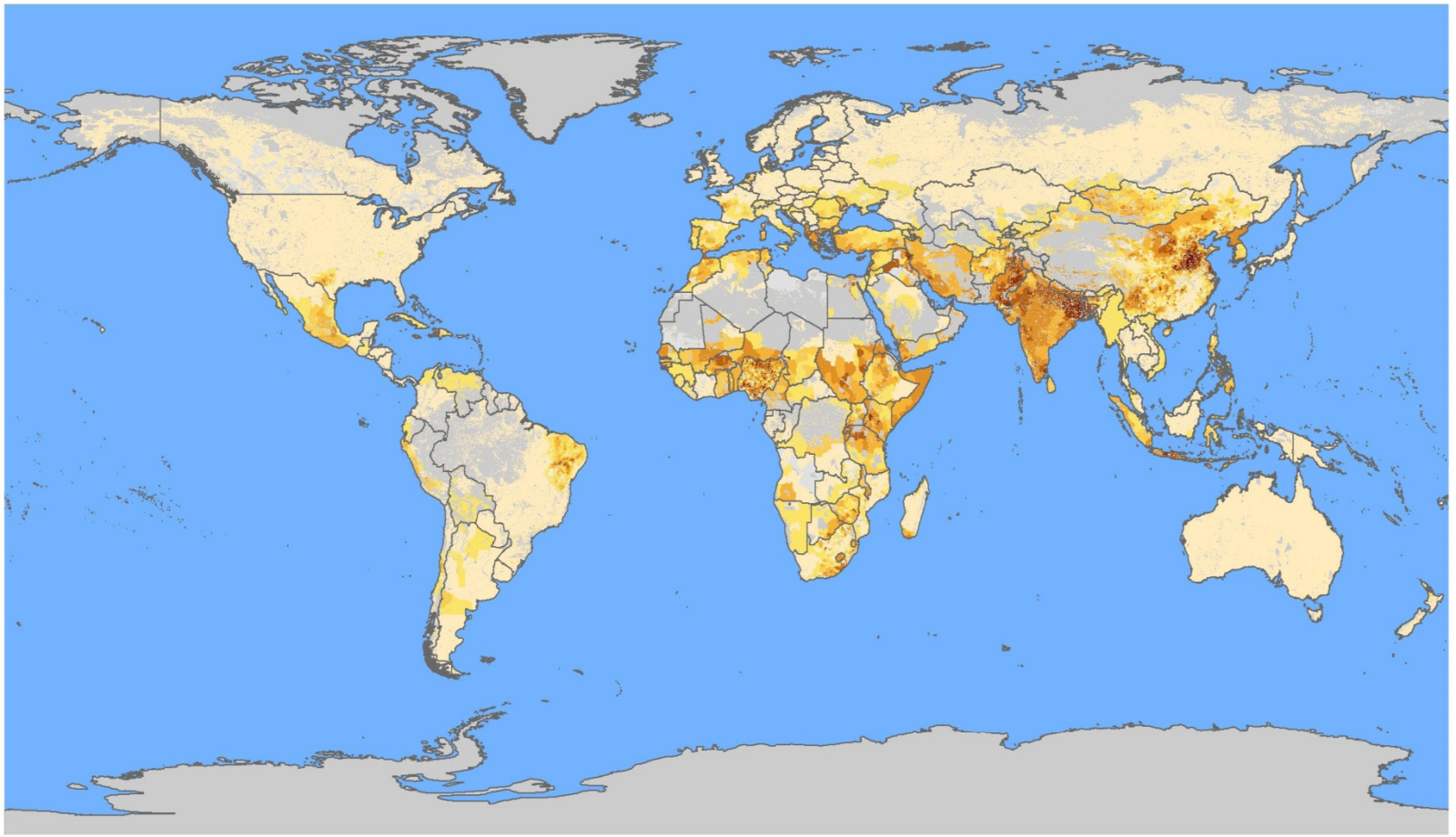


Number per square km

<1	5–10	20–50	100–250	Water
1–5	10–20	50–100	>250	Unsuitable for ruminat

Source: Gridded Livestock of the World

EU- 27 sheep & goat meat ('000 T) - Production

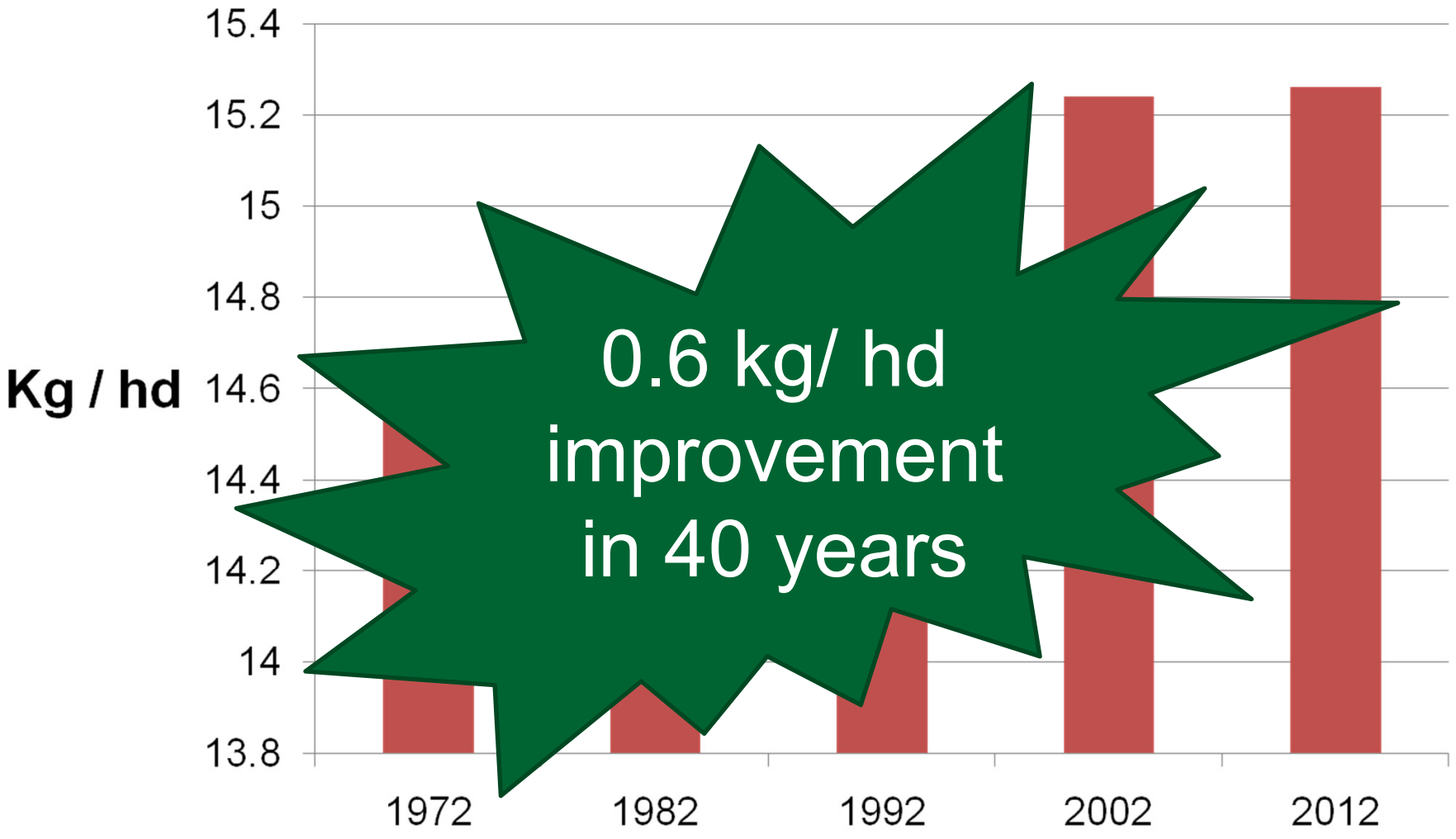
	2010	2011	2012e	2013f	2014f
Gross Indigenous Production	934	951	938	915	887
Live Imports	0	0	0	0	0
Live Exports	11	22	27	21	23
Net Production	923	929	910	895	864

Directorate-General for Agriculture and Rural Development - Short Term Outlook – N°5
http://ec.europa.eu/agriculture/analysis/markets/index_en.htm

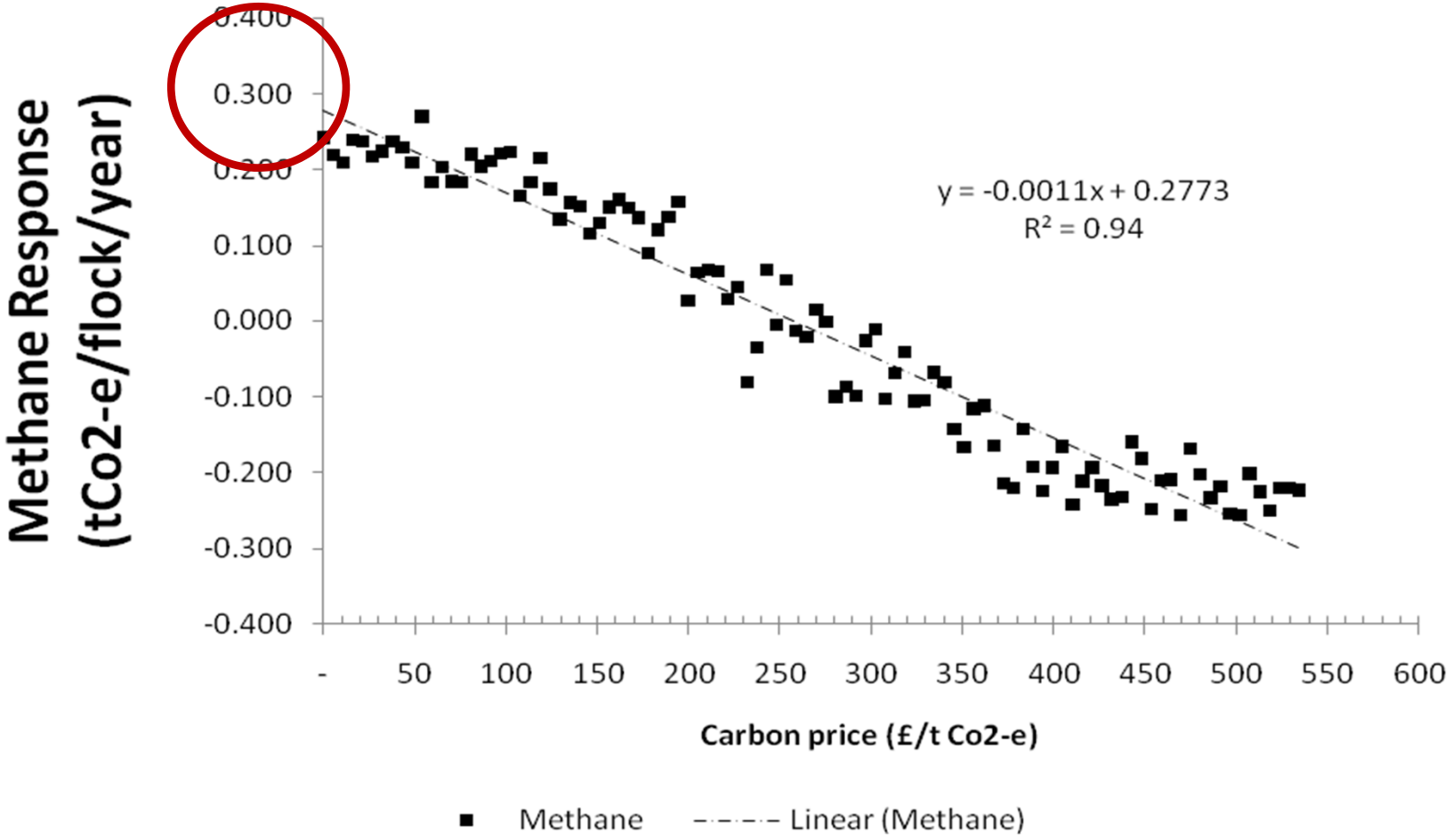
EU- 27 sheep & goat meat ('000 T)

	2010	2011	2012e	2013f	2014f
Meat Imports	**239**	**222**	**189**	**197**	**213**
Meat Exports	**13**	**16**	**25**	**27**	**23**
Consumption	**1 149**	**1 135**	**1 074**	**1 064**	**1 054**
population (million)	502	503	504	505	507
p.c. Consumption (kg)	2.3	2.3	2.1	2.1	2.1
Share in total meat consumption	*2.7%*	*2.7%*	*2.6%*	*2.6%*	*2.5%*

Productivity?
Sheep meat – Europe 1972-2012



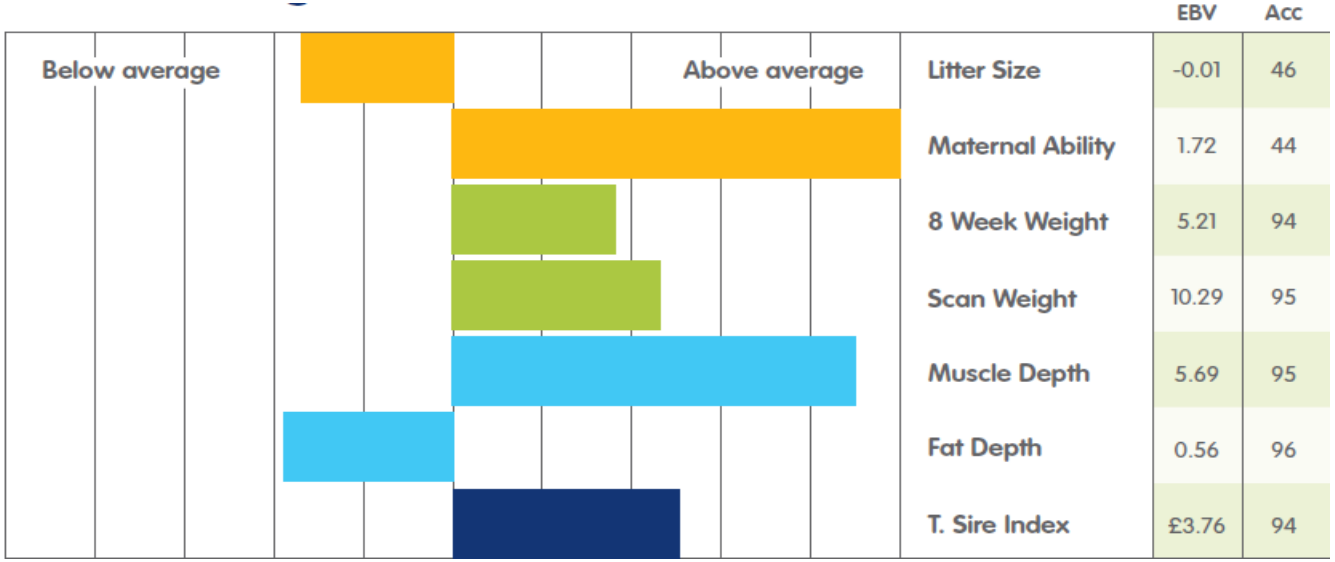
Extensive - sheep



Focus Farms (n=9)
Demonstrating financial gains

Over 6,000 lambings, 6 years (2006-2012)

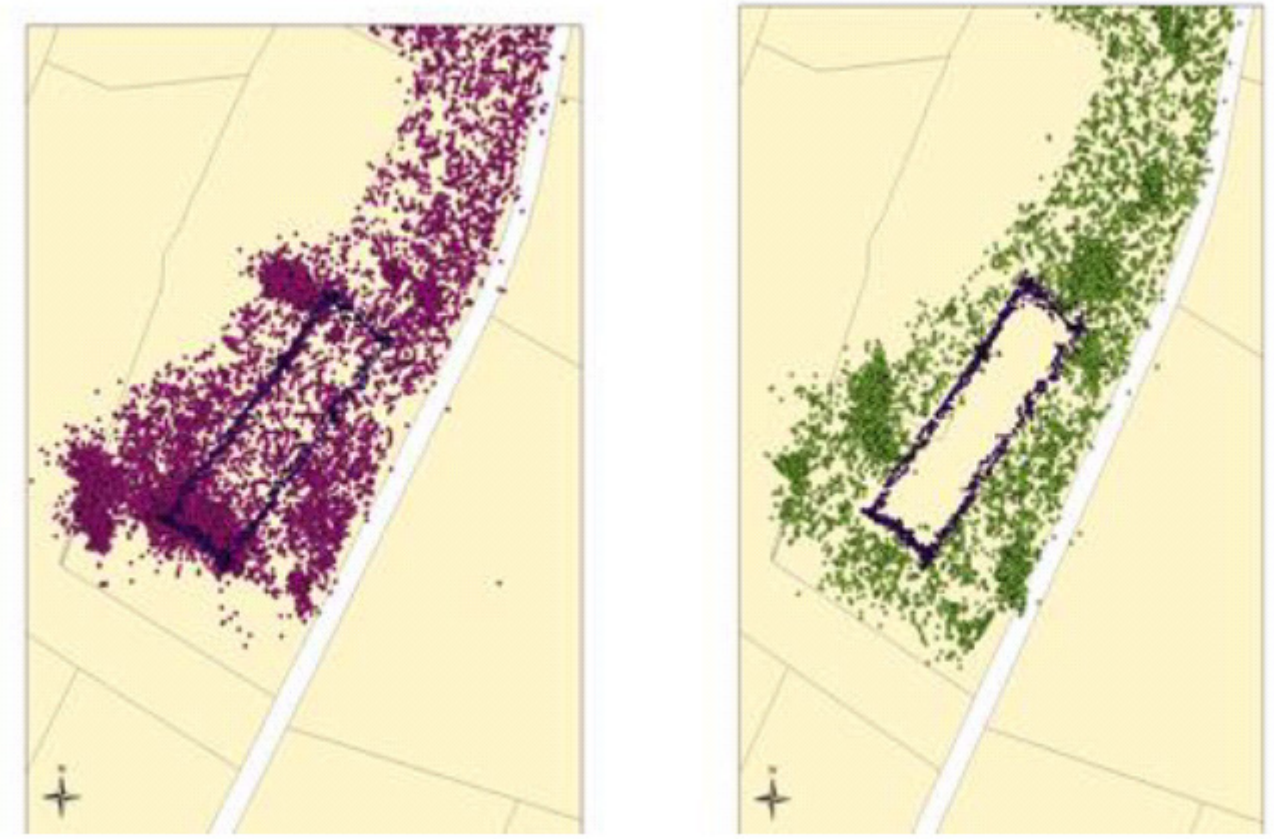
High (top 5%) index vs 'farm choice' rams



http://www.qmscotland.co.uk/sites/default/files/bbphase2final.pdf


Balancing environmental management with production?

Precision farming – virtual fencing



Some results – weaning 2012

- Weaning 2012 – all 244 male lambs
  - 64 → no dose
  - 42 → small dose (4 ml)
  - 113 → medium dose (6 ml)
  - 25 → high dose (8 ml)

Conventional:
all (244 lambs) got **8** ml

- Savings per lamb £0.08 - £0.09
- In total: £20 savings

Breeding has potential to reduce methane

Investigated impacts of:-

- Using different carbon prices (£0-£538/t CO_2-e)
- Including feed intake as a breeding goal*
- Measuring / not measuring methane/ feed intake directly
- Different feed costs*
- Different ways to 'express' GHG
- Impacts on 9 breeding goals (15 traits)

Cottle, D.J. and Conington, J. 2013. Reducing methane emissions by including methane production or feed intake in genetic selection programmes for Suffolk sheep. J. Agric.Sci. 151: 6 872-888

Cottle, D.J. and Conington, J. 2012. Breeding for reduced methane emissions in extensive UK sheep systems. J. Agric.Sci. 150: 5, 570-583.

Lambe, N.R., Wall, E., Ludemann, C.I., Bunger L. and Conington, J., 2014. Genetic improvement of hill sheep – Impacts on profitability and greenhouse gas emissions. Sm. Rum. Res.120: 27-34.

What's important for efficient sheep and goat production?

SRUC

Meat production

- No. offspring weaned/year/female mated
- Annual death rates
- Length of productive life
- Total weight of offspring weaned/year/female exposed to the male
- 12–18 month body weight

Agriculture contributes ~9% to UK GHG emissions