Longevity – a traditional concept with a future?

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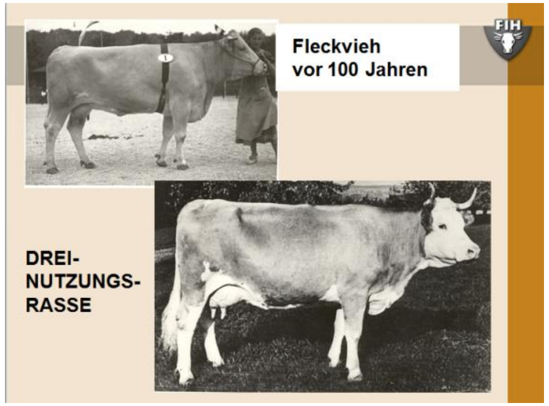
Longevity - history

- Charles Darwin (1859) introduced **fitness as a concept for natural selection** when there is competition for limited resources
- The **natural lifespan of a cow is estimated at approximately 20 years** (Nowak, 1999)
- Essl (1992): Selection for increase in production – **negative genetic correlations between production and fitness traits** - detoriation of longevity is expected



1920: 1,300 kg milk

1950: 3,000 kg milk

Now: 8,000 -10,000kg milk

Source: RZA, Fleckvieh AUSTRIA
Unterlage: Miesenberger

- History of genetic evaluation for (functional) longevity – starting point for breeding for fitness!

1995 Austria 1997 France 1998 Germany 1999 Netherlands, more countries starting >=2000 (Italy, ..)

Requirements for a ‘sustainable’ cow

Efficient and healthy, economical, low ecological footprint

Breeding goal:

- high milk yield
- high feed efficiency
- good fertility
- **long productive life**
- good milk quality - healthy udders
- no or few claw problems
- no or few problems with metabolism
- resilient (heat stress,...)
- low emissions
- good beef performance
- ..

Further requirements:

- animal welfare
- low ecological footprint / fewer emissions - climate targets 2030/2040
- low use of antimicrobials

Foto: HBLFA Raumberg-Gumpenstein

many challenges

Longevity – trait of interest in several dimensions (economics, animal welfare, environment).

Longevity – different aspects to balance

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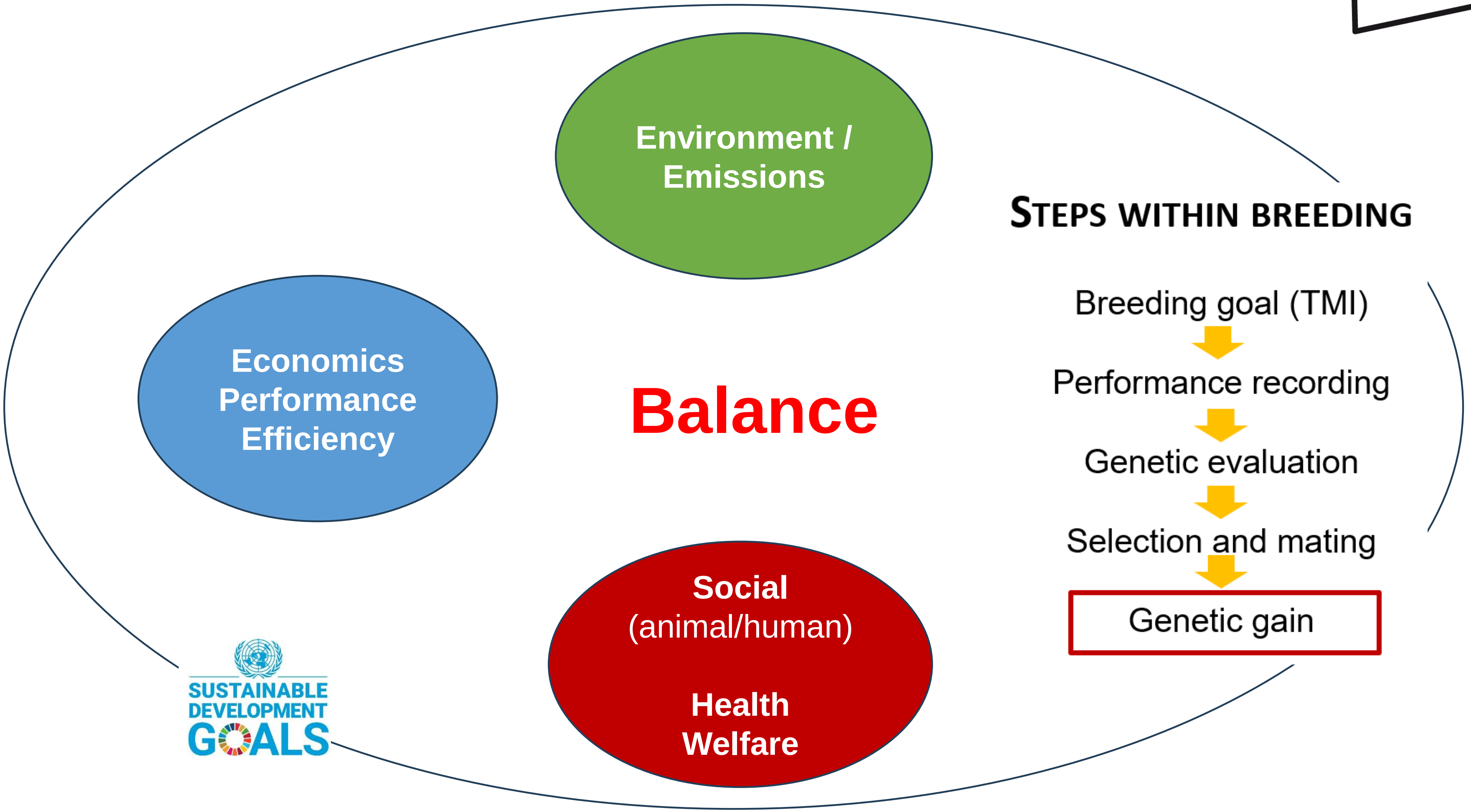
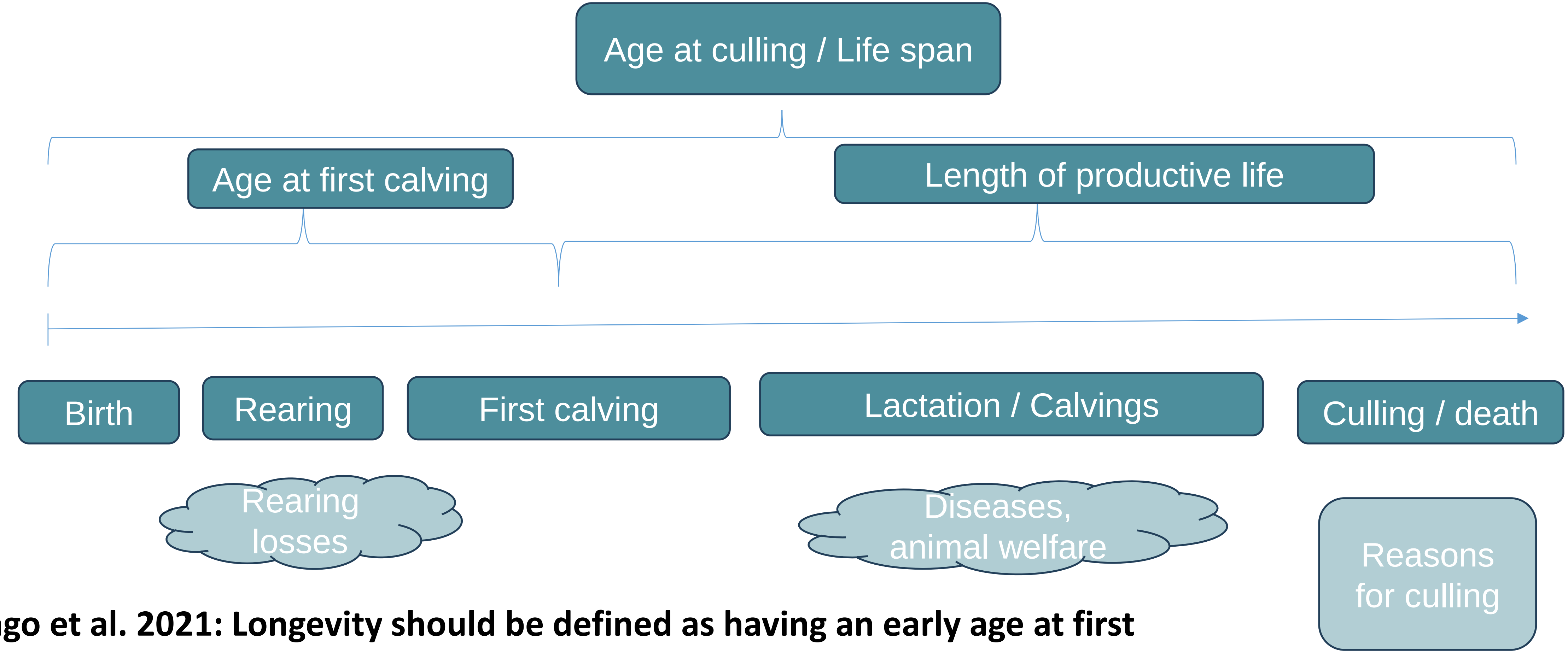


Longevity – trait definition and Status-Quo

Definitions around longevity:

Life span / Age at culling / Length of productive life /



Dallago et al. 2021: Longevity should be defined as having an early age at first calving and long productive life spent in profitable milk production

Definitions around longevity

- **Life span / Age at culling / Length of productive life / ..**
  - Many influencing factors in addition to genetics
  - Trait independent of management of interest for breeding
- **Longevity – length of productive life**: Period between first calving and culling
- **Functional longevity:**
  - The ability of the cow to avoid involuntary culling, e.g. due to fertility or milk yield
  - Corrected for voluntary culling to account for the influence of relative performance in the herd - **TRAIT FOR GENETICS!**
- **Lifetime milk yield:** Milk produced throughout the cow's entire life

Methodological challenge: 'true' phenotype available at end of life – !generation interval!

International - milk yield and length of productive life (Dallago et al. 2021)

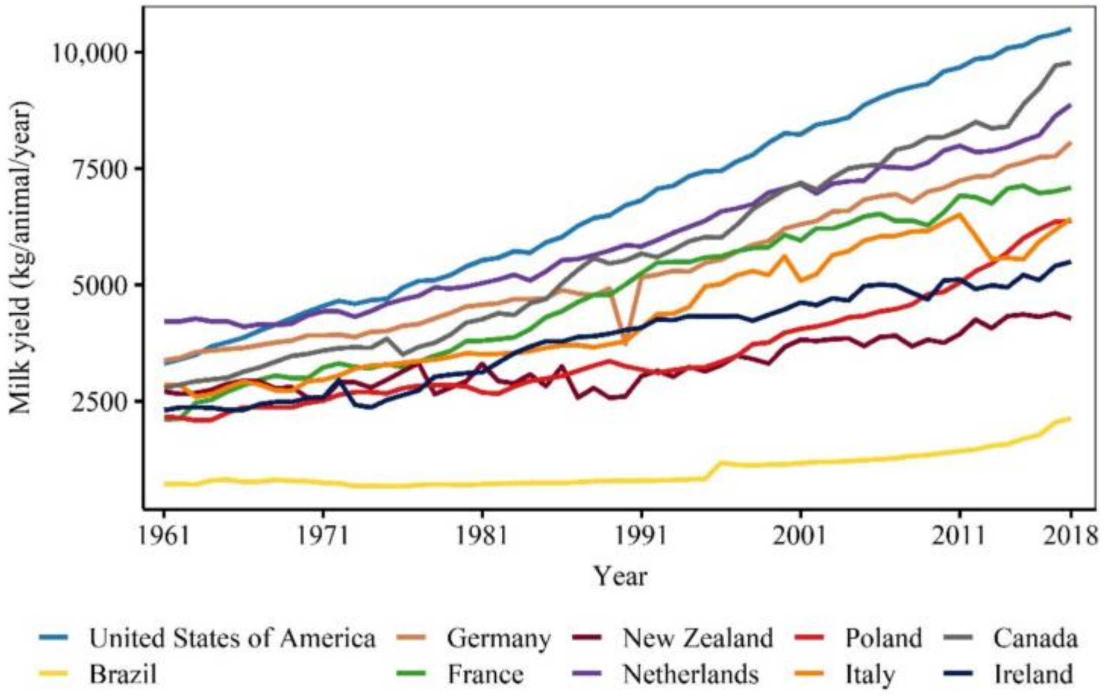
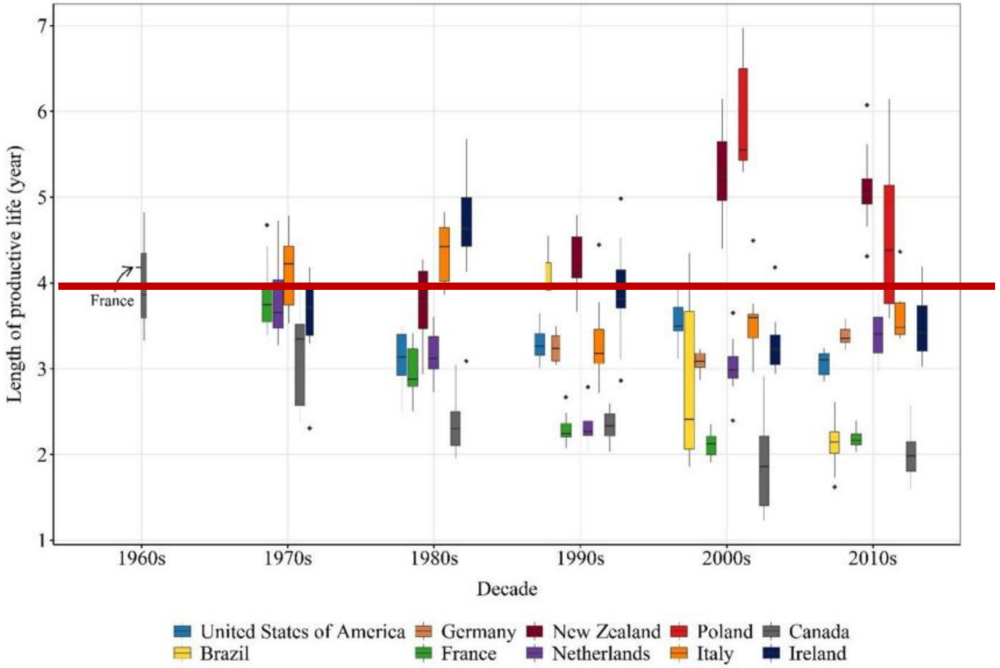


Figure 4. The average milk yield (kg) per animal from the top 10 high milk-producing countries over the years. The list of countries is limited to the world's top high milk-producing countries for which we were able to provide sufficient and reliable data on the length of productive life. Data sources are provided in Table A1.

AT 2024
8,000 kg



AT 4
Years

Figure 5. The length of productive life (year) of dairy cows from the top 10 high milk-producing countries on different decades. The relative width of each box per country within decades represents the number of observations available to generate it. The wider the box, the more observations were available. The list of countries is limited to the world's top high milk-producing countries for which we were able to provide sufficient and reliable data on the length of productive life. Full circles (●) represent values above or bellow the interquartile range. Data sources are provided in Table A1.

Factors influencing longevity of cows

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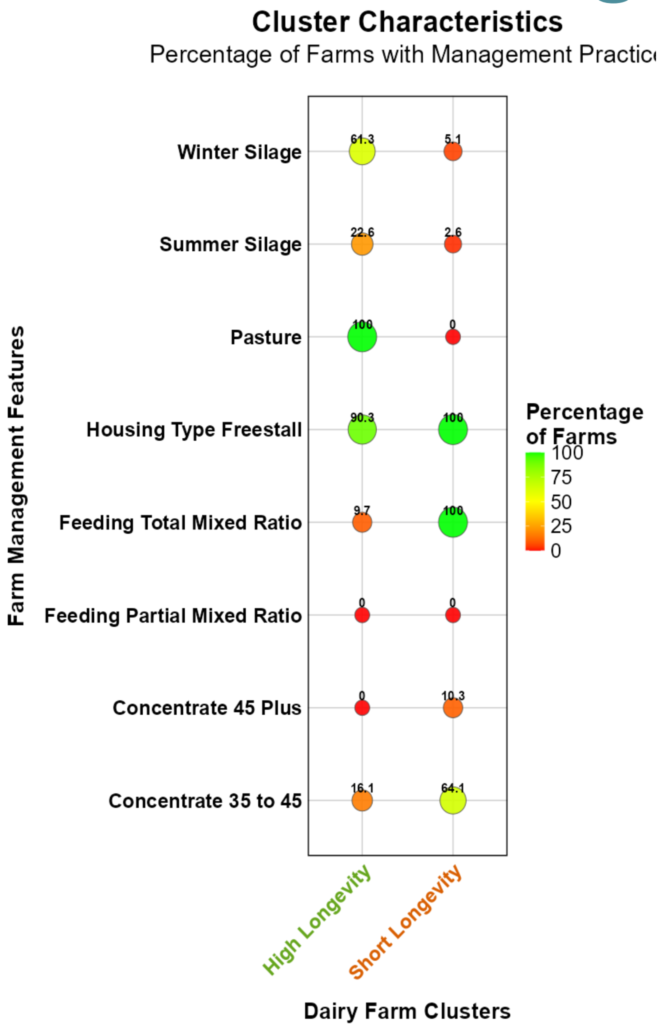
Impact factors on longevity of a dairy cow

- Genetic Gain (GG)
- Costs for replacement
- Maturity/development
- Value of the calf
- Age costs of a cow (risk of diseases)

Figure: adapted from Sherwin (2024)

Economics: An old cow should be replaced if the expected contribution margin is lower than the maximum expected contribution margin of a replacement heifer (Mißfeldt et al. 2015).
Animal welfare/animal health: as long as "healthy", a long useful life is positive

Differences between farms with high and low length or productive life



- **Cluster analyses** with 332 D4Dairy Farms
- **Method:** key-feature based clustering approach

cluster	farms	L. Productive life (alive) (years)	Milk Production	
1	39	2.89	9873.07	Short Longevity
2	79	2.93	9503.22	
3	52	2.95	8612.15	
6	104	3.03	8854.22	
4	21	3.09	8672.78	
5	31	3.50	7530.84	High Longevity

Matzhold, 2025

Impact factors: pasture ↑, organic ↑ milk yield ↓, concentrate level>35% ↓, TMR feeding ↓

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Longevity, health and animal welfare – closely connected!

Heritabilities and genetic correlations

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Heritabilities:

- Milk yield: 30-40%; Beef, Conformation: 20-40% ,
- Fitness, Health: 1-15%
- Longevity traits: 9-13%

Genetic correlations of longevity with Fleckvieh TMI: (Fürst et al. 2025)

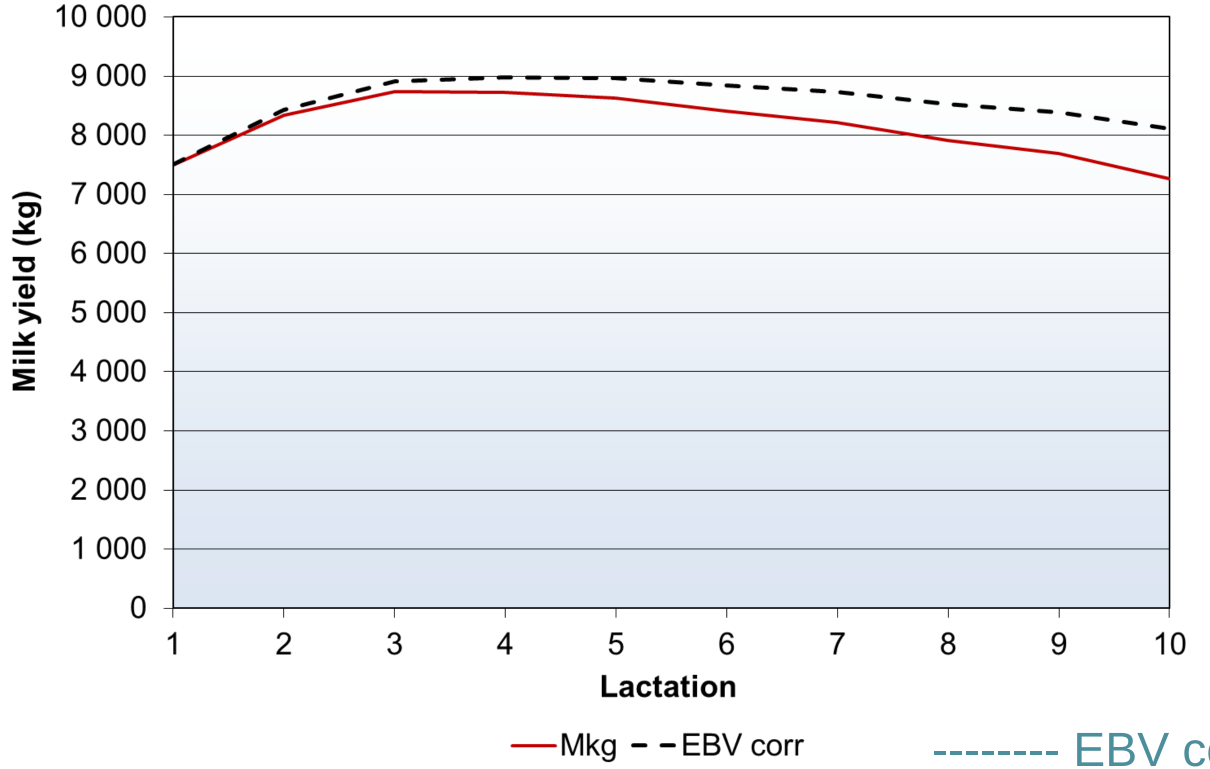
- milk traits (fat kg, protein kg) **- 0.25**
- reproduction index **+0.50**
- udder health index **+0.50**
- conformation e.g. overall udder: **+0.40**, feet & legs: **+0.30**

Strong positive correlation between health, selected conformation traits and longevity!

Longevity and economics

Longevity and economics

Highest milk yield in 3rd - 5th lactation (Fleckvieh, 2024)



-------- EBV corrected milk yield per lactation

Cows should stay in production at least 5 lactations from the point of view of peak milk yield!

BUT: Higher incidence of diseases in higher lactations, higher risk of cullings in higher lactations

Health disorders by lactation – Fleckvieh 2024

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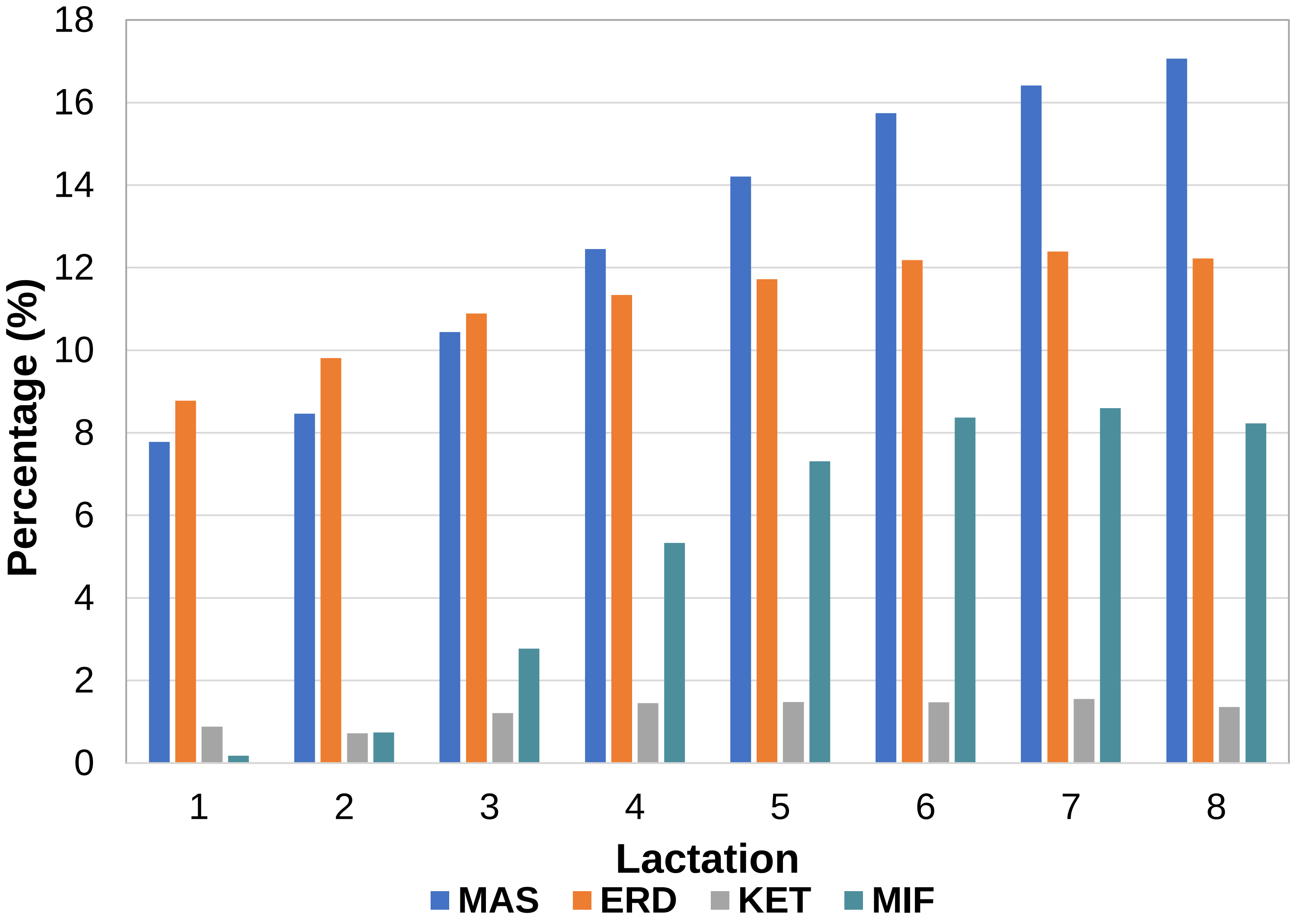
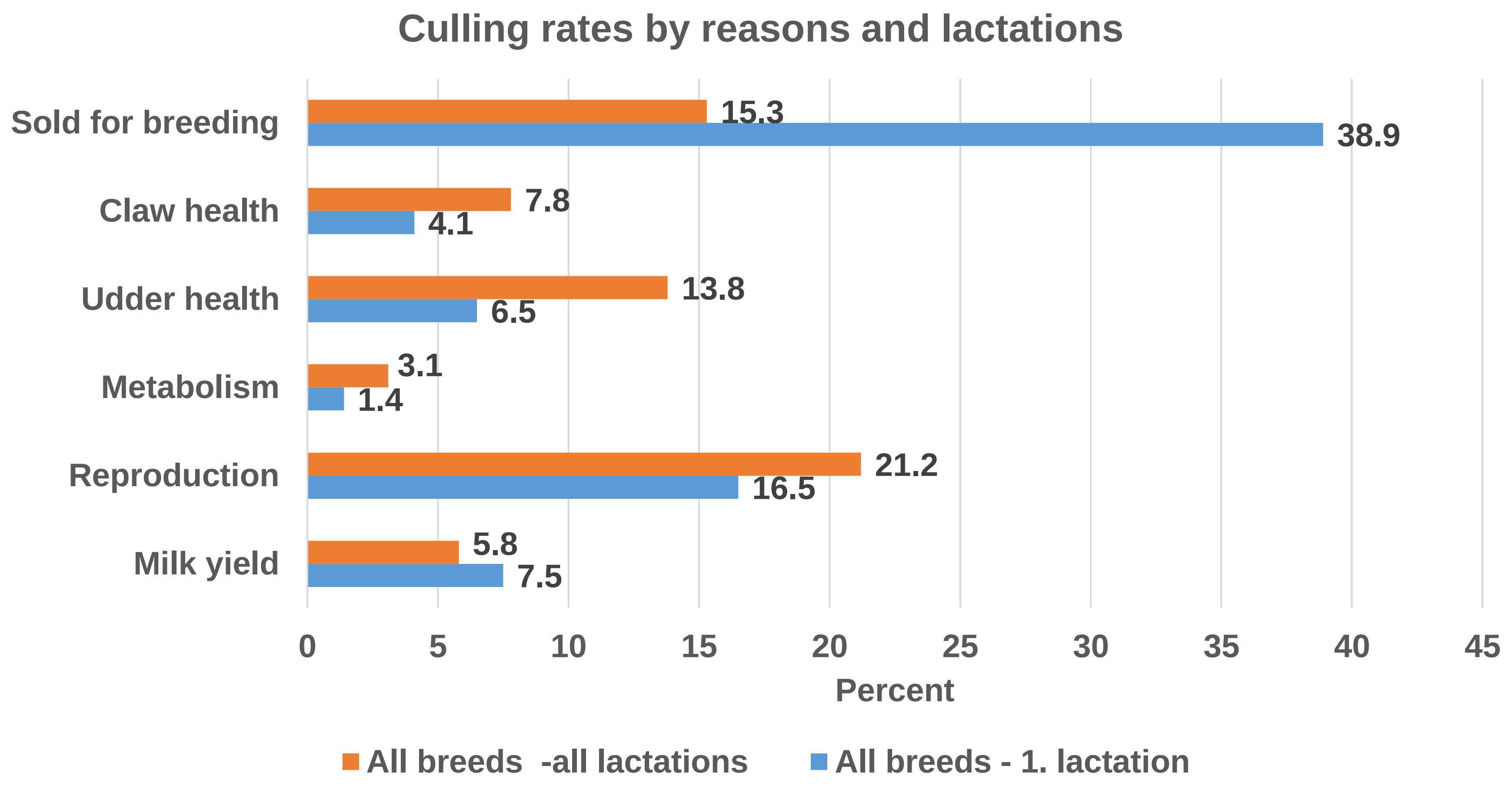


MAS	Mastitis
ERD	Early reproductive disorders
KET	Ketosis
MIF	Milk fever

Health problems increase with lactations!

Longevity and culling (AT all breeds)

Culling reasons 2024 (all lact / 1st lact)



Longevity and economics

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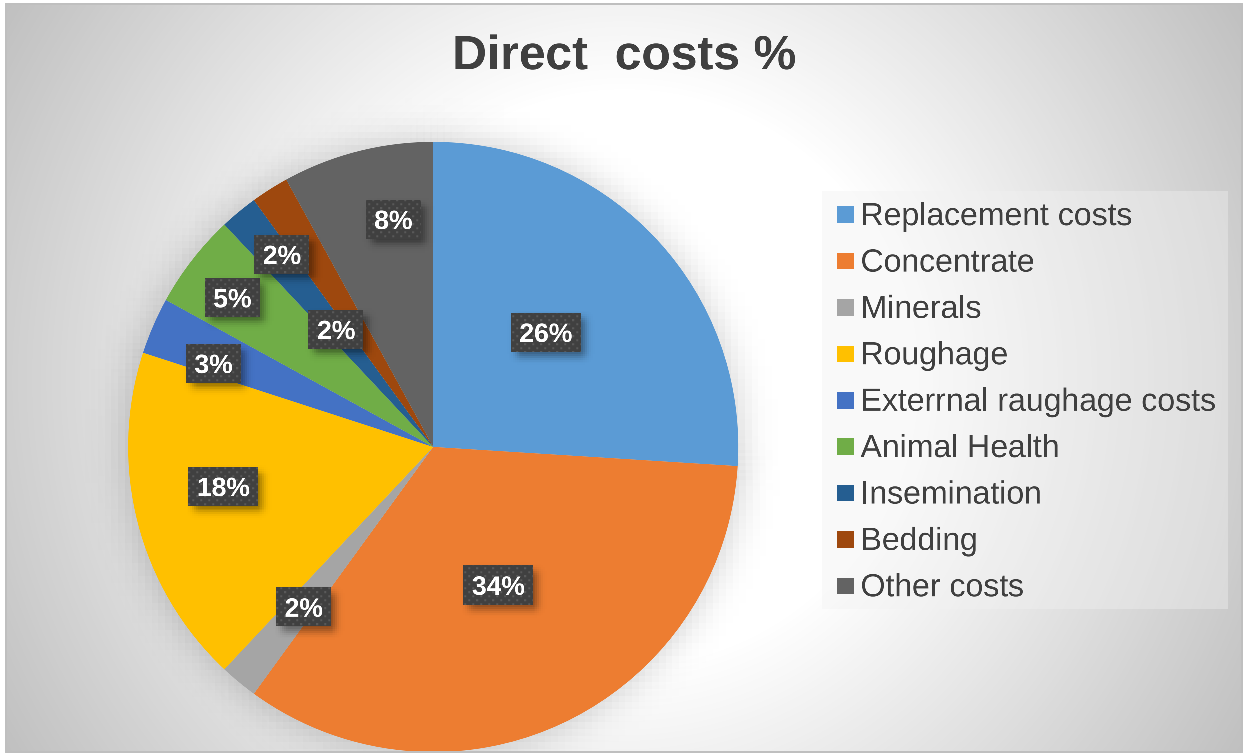


- **Cow replacement costs about 25% of direct costs for milk production are in second place in terms of costs** (Horn, 2025)
- **Cost savings from additional lactations** – reduced culling
- Don’t forget costs related to losses of calves and heifers!
- **Cost savings due to improved animal health and welfare** (including indirect costs (milk loss,..!)

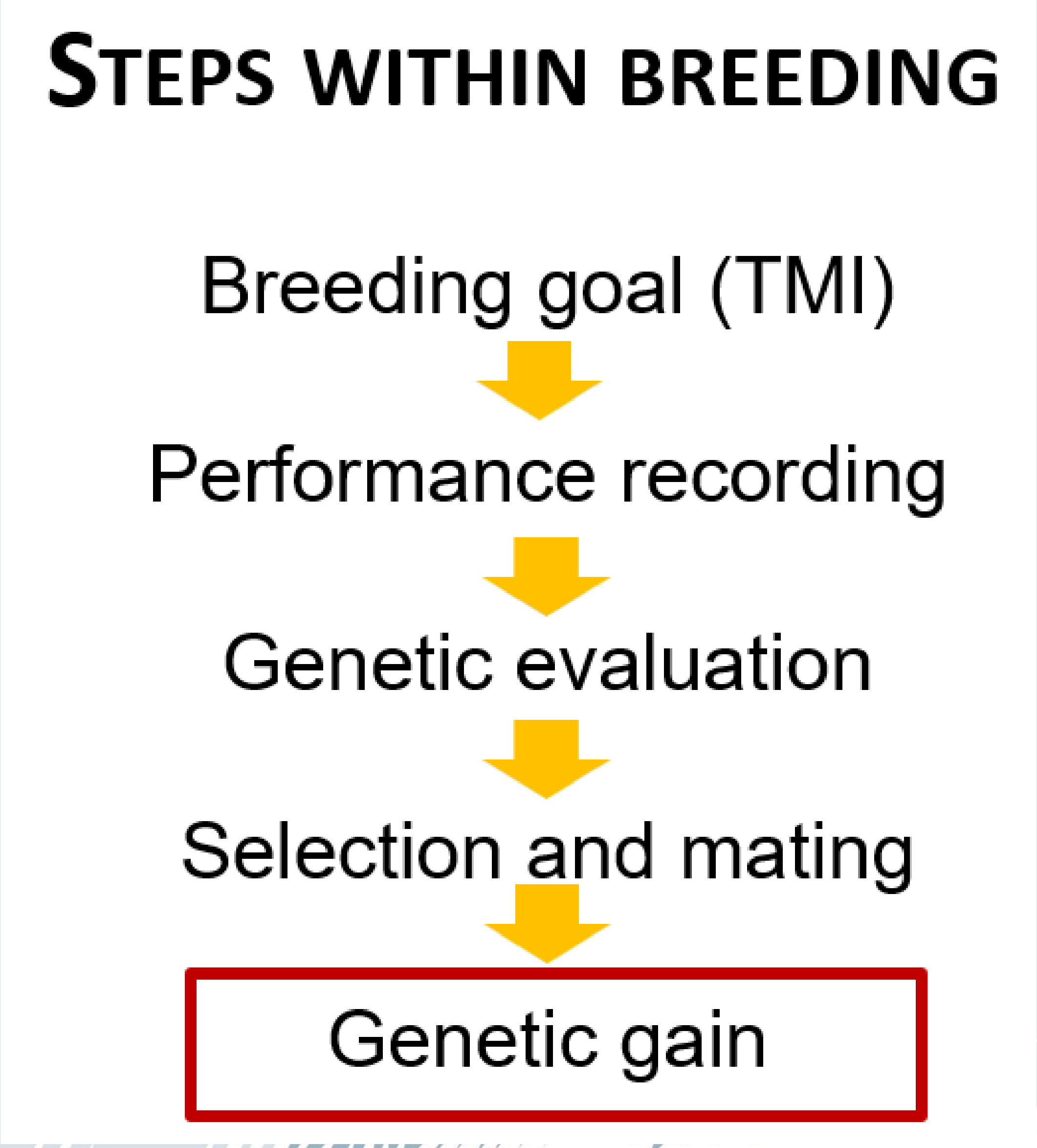
Source: Horn, 2025 https://www.rinderzucht.at/downloads/seminarunterlagen.html

Increase of longevity and improved health status is needed / desired!!!!

Longevity and genetics

GG/year = $\frac{i * rEBV * \sigma a}{GI}$

Optimisation on all levels!



Trait definition and genetic evaluation for functional longevity in Austria – Key facts

Longevity / length of productive life: 1st calving till culling

- Only known after death; model includes living animals
- Strongly influenced by milk yield → not a biological fitness measure

Functional longevity – trait for genetic evaluation:

- Adjusted for culling due to milk performance (considers relative performance within herd), other management effects considered

Timeline – joint genetic evaluation for functional longevity:

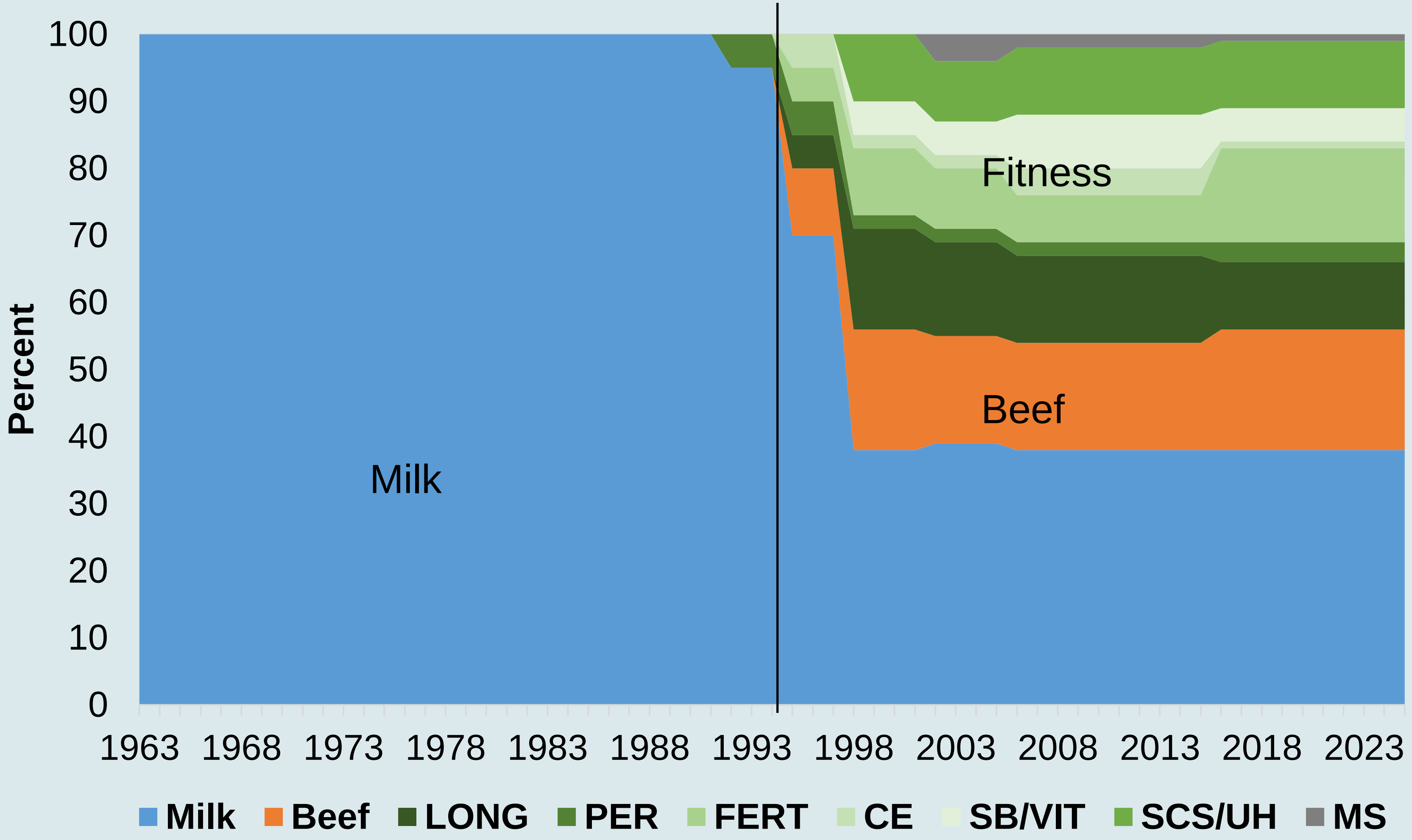
- 1995 Austria → 2001 Germany → 2016 Czechia → 2018 Italy → 2023 Slovakia

Method / software:

- 1995–2001: Smith / Egger-Danner program
- Until 2021: Survival analysis (“Survival Kit”) Ducrocq / Sölkner
- Since 2021: Single-Step BLUP (MiX99)

Historical development of EBV/TMI (Fleckvieh)

Joint breeding value estimation (DAC) with Germany, Austria, Czech Republic,.



till 1992 only milk

1995 Functional longevity u.a.

1998 Total Merit Index (TMI)

2002 with Germany

2010 Health traits

2010/11 Genomics

2021 Single-Step

2023 Claw health

30 years of routine genetic evaluation of functional longevity in AUSTRIA – first country worldwide!

TMI – economic weights

	Fleckvieh	Brown Swiss	Holstein
Trait	GZW	GZW	RZG
MILK	**38**	**50**	**36**
BEEF	**18**	**5**	**0**
FITNESS	**44**	**45**	**49**
CONFORMATION	**0**	**0**	**15**
Milk yield			
Fat yield	18.6	20.7	14
Protein yield	19.4	27.8	22
Protein content		1.5	
Net gain	4	3	
Dressing perc.	7	1	
Trade class	7	1	
Longevity	10	12	18
Persistency	3	3	
Fertility	14	15	7
Calving ease	1	1	3
Vitality index	5	4	3
Udder health[1]	10	10	18[1]
Milkability	1		
Conformation (RZE)			15

Longevity / length of productive life Fleckvieh:

1998: 15%

2002: 14%

2006: 13%

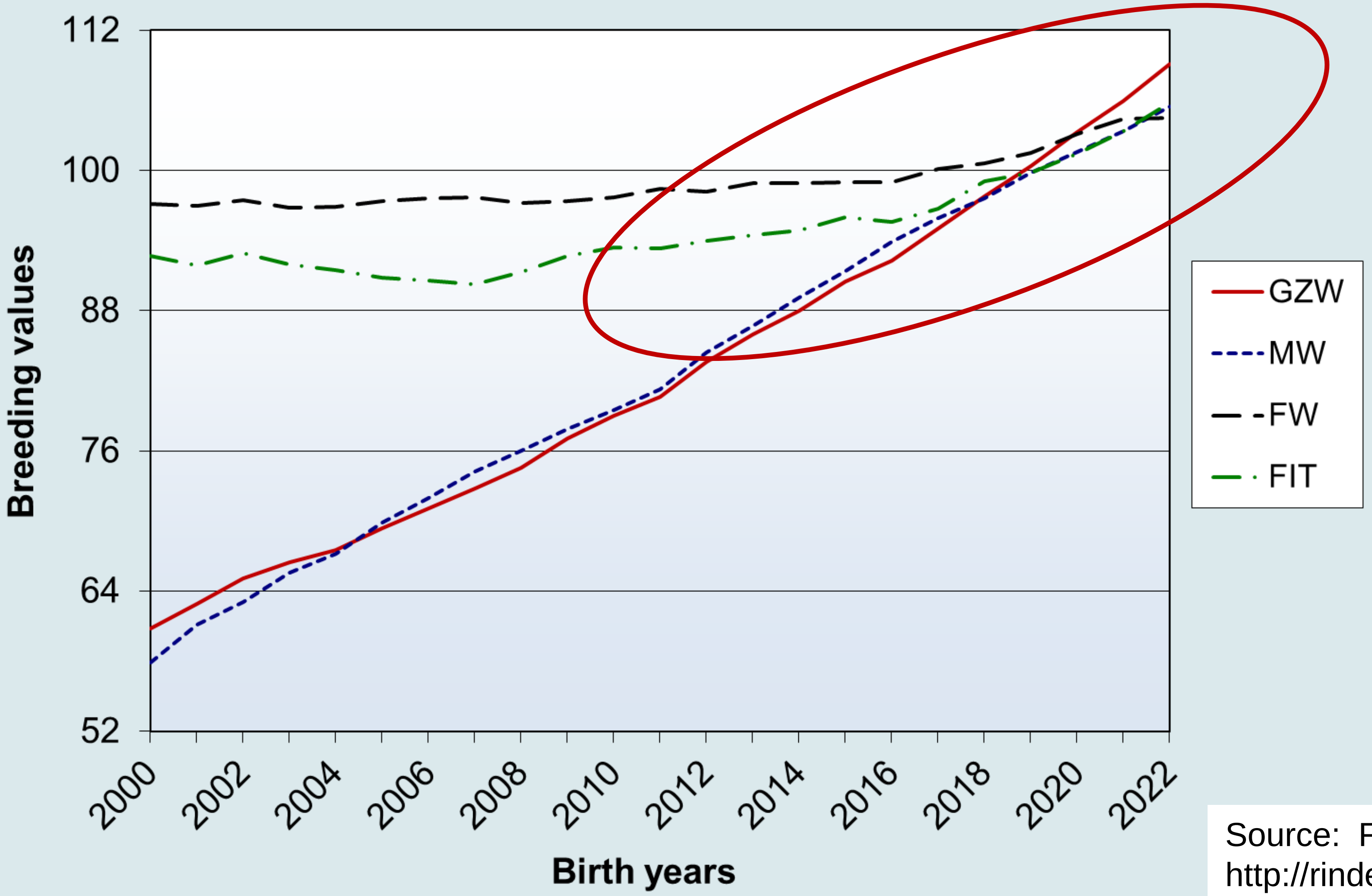
2016: 10%

2027: ?

Source: Fuerst et al. 2025
http://rinderzucht.at/downloads/seminarunterlagen.html

[1] RZ Gesund

Genet. Trend – TMI – Fleckvieh cows



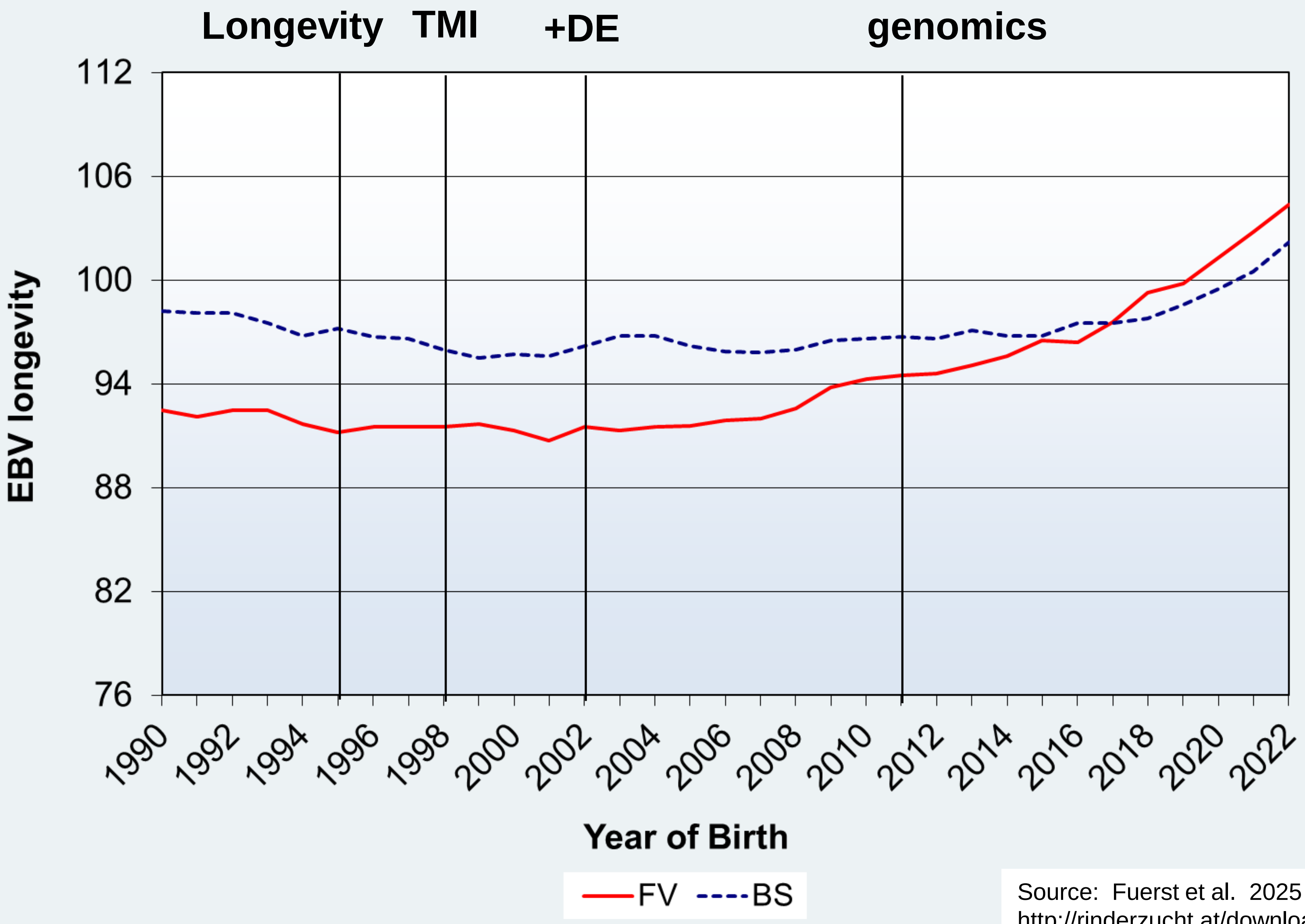
High breeding progress in milk possible with genetic stabilisation or improvement of other traits in the overall breeding value (GZW)!

Data availability, quality and scope essential for breeding progress - new traits!

Source: Fuerst et al. 2025
http://rinderzucht.at/downloads/seminarunterlagen.html

Increase breeding progress faster through genomic selection - e.g. fitness!

Genet. Trend – length of productive life – cows



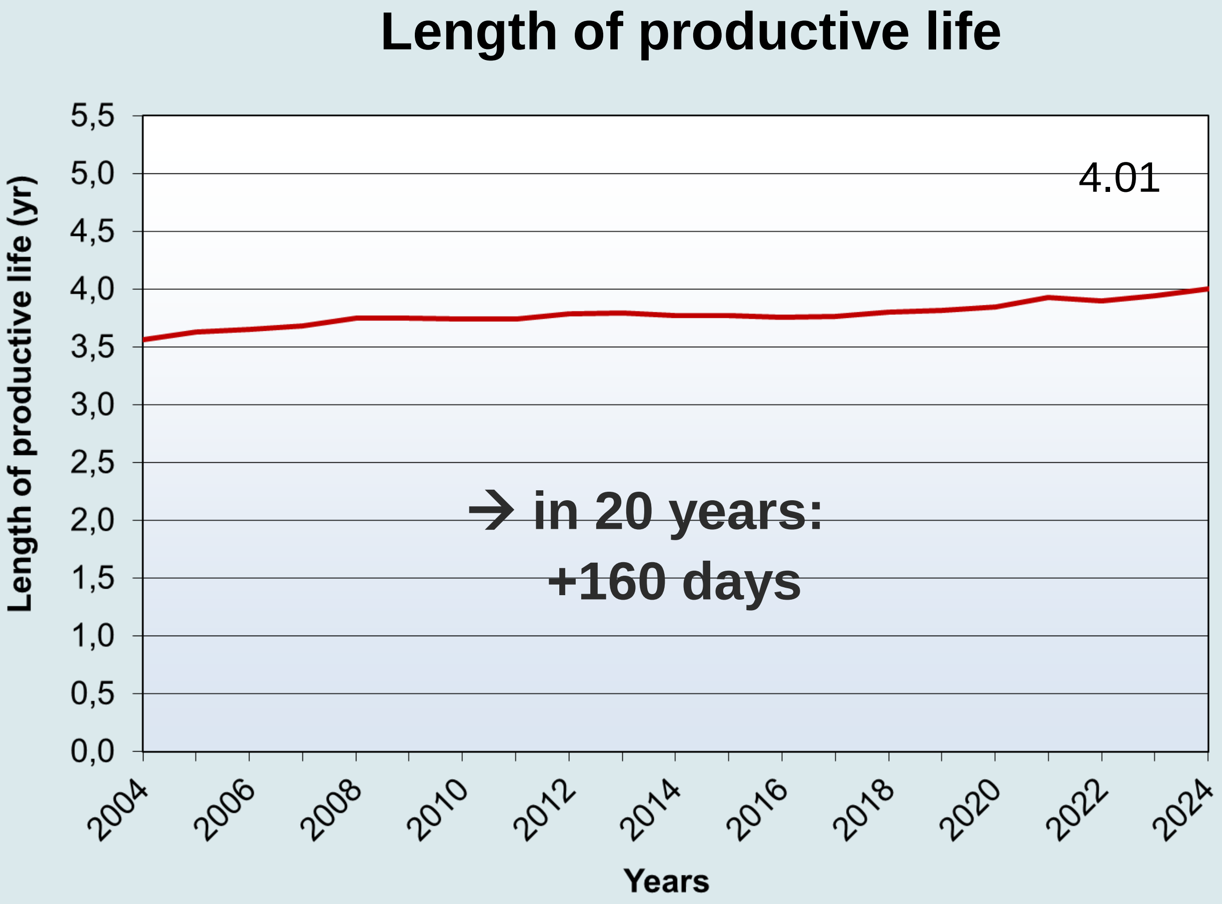
→ EBV/TMI works!

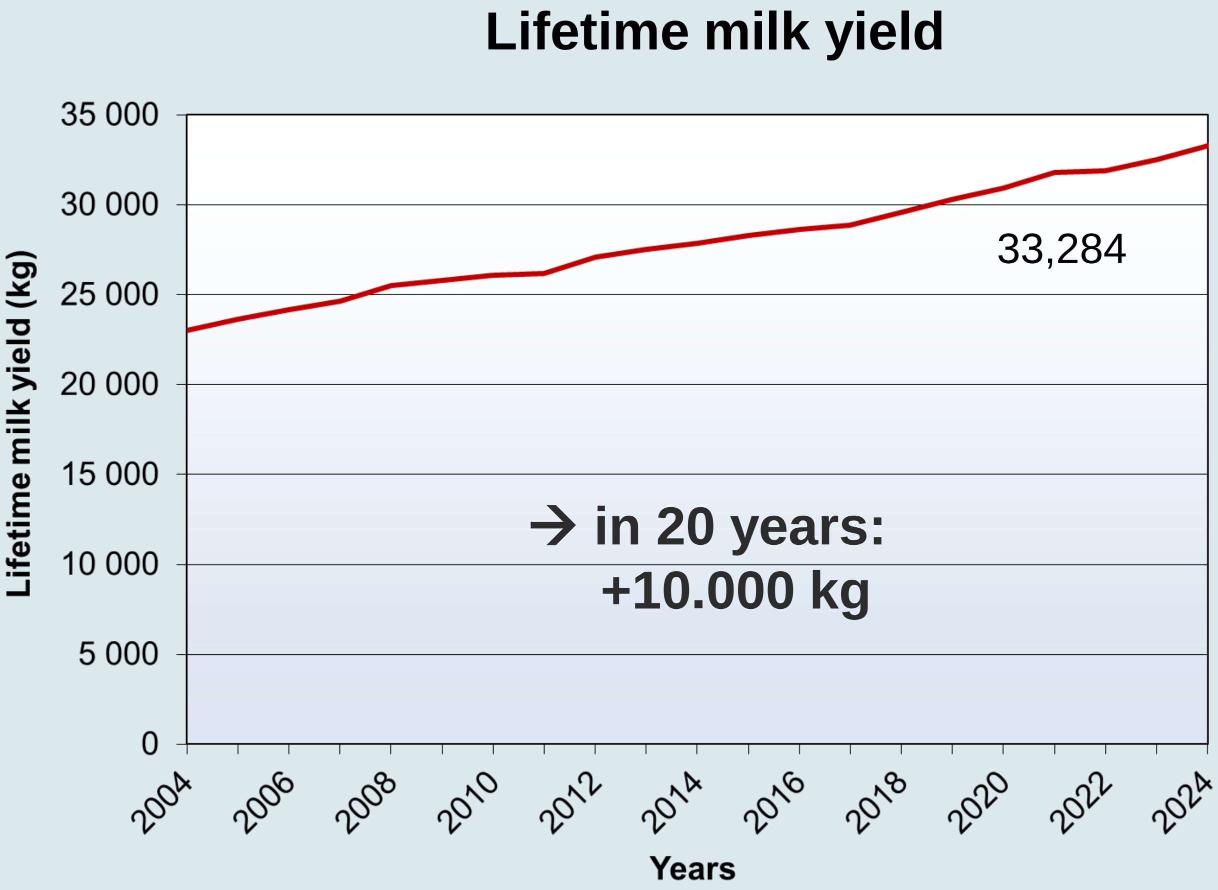
Genetic gain in days per year / last 20 years:

	FV	BS
genet. trend	9,7	4,5

Source: Fuerst et al. 2025
http://rinderzucht.at/downloads/seminarunterlagen.html

Length of productive life and lifetime milk yield in Fleckvieh Austria

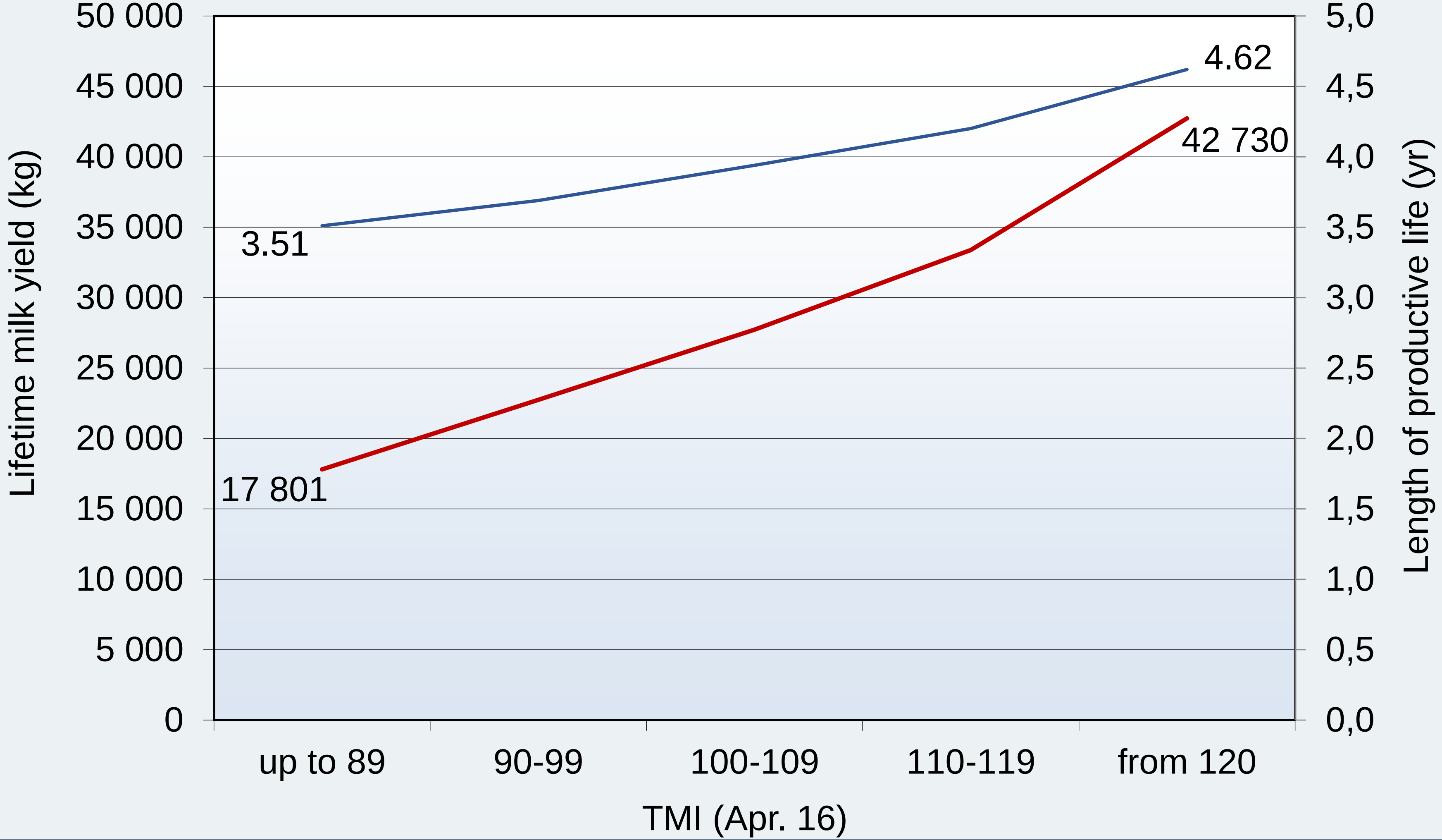




Fürst, 2025

TMI – Life time milk yield – longevity

Fleckvieh cows, Year of first calving 2015, EBV Apr. 2016



Breeding for TMI works for longevity and total life time milk yield.

Longevity and environmental impact

Further information:


BOKU UNIVERSITY

NEU.rind
Nachhaltigkeit • Effizienz • Umweltwirkung

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'NEU.rind'– A User-Friendly Digital Tool Applied for Sustainability Assessments of Austrian Dairy Farms

S. Hörtenhuber[1]*, F. Steininger[2], M. Herndl[3], K. Linke[2], C. Matzhold[2], S. Wieser[4], C. Egger-Danner[2]

1 BOKU University Vienna, 2 ZuchtData, 3 AREC Raumberg-Gumpenstein

EAAP Conference 2025, Session 28, 26.8.2025, Innsbruck, Austria

Projektpartner

Wissenschaftspartner

Kooperationspartner

Mit Unterstützung von Bund und Europäischer Union

Source: Hörtenhuber 2025 http://rinderzucht.at/downloads/seminarunterlagen.html

NEU.rind – Results from 170 farms in Austria

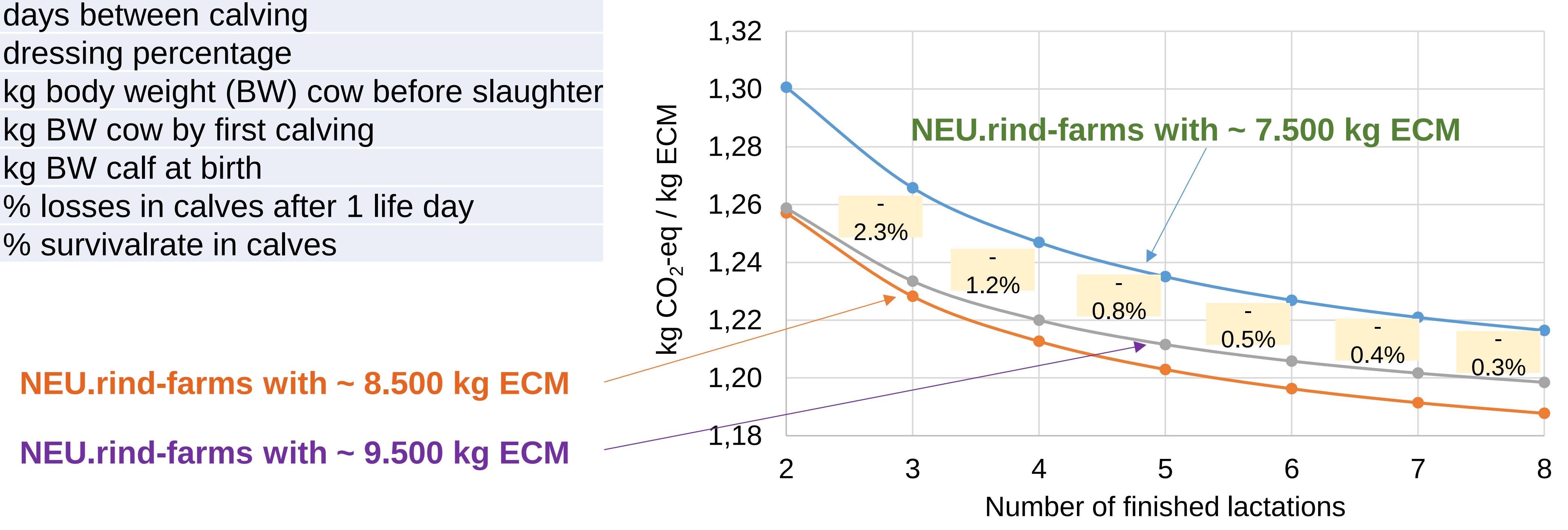
Indicators		Results of the Top 10%-farms for animal health	/ longevity
Global warming potential (CO_2-eq)	per ha	-8 %	**-36 %**
	per kg energy corrected milk (ECM)	-4 %	**-9 %**
Ammonia (NH3)	per ha	-15 %	-32 %
Acidification (SO_2-eq)	per kg milk (ECM)	+21 %	+13 %
Fossil energy demand	per ha	-6 %	**-29 %**
	per kg ECM	-1 %	+0.3 %
Gross-protein production	per ha	-10 %	-31 %
Feed-food-protein conversion efficiency	per kg human edible protein in feed	+42 %	+62 %
Concentrate use	per kg ECM	-20 %	**-23 %**
High Nature Value Farmland, HNVF	ha/ha	+5 %	-3 %

Source: Hörtenhuber, 2025 http://rinderzucht.at/downloads/seminarunterlagen.html

Modell calculation to the effect of longevity with NEU.rind – results – CO_2-eq

7.500 8.500 9.500	kg herd perforance per year (ECM)
28	month of first calving
390	days between calving
50%	dressing percentage
700	kg body weight (BW) cow before slaughter
600	kg BW cow by first calving
42	kg BW calf at birth
5%	% losses in calves after 1 life day
95%	% survivalrate in calves

Finished lactations	2	3	4	5	6	7	8
kg lifetime milk yield	17 000	25 500	34 000	42 500	51 000	59 500	68 000



Source: Hörtenhuber, 2025 http://rinderzucht.at/downloads/seminarunterlagen.html

Longevity and environmental impact

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- **Pure effect of longevity limited**, but i**n combination with health and performance very relevant**
- Increased length of productive life needs **less replacement heifers (less emissions due to rearing)**
- **Increased health status – less indirect losses due to reduced milk yield**,…
- **Exploiting the biological potential for increasing milk yield**, thereby reducing 'immaturity costs' (De Vries, 2020) and methane emissions (Grandl et al., 2019)
- **Better combination of production of milk and beef with decrease of emissions** if fewer offsprings are needed for milk production (Probst et al., 2019)

Longevity impact on sustainability - combination economic, social, environment

Longevity and outlook

Length of productive life / longevity should be increased because of animal welfare, economics and environmental aspects (aim: 5 years?!) by **genetics and management!**

Future developments / Outlook

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- **Animal health / welfare of increased importance –** consumer demands, sustainability
- **Many new traits of interest in the future – broader breeding goal ?!**
  - example AUSTRIA: metabolism, feed efficiency, methane?, calves / heifers related traits (health, behaviour, ..), resilience, heat stress
- **New possibilities due to digitalisation, artificial intelligence**
  - partly higher heritabilities expected

NEW - JDS INVITED REVIEW: Using data from sensors and other precision farming technologies to enhance the sustainability of dairy cattle breeding programs

Luiz F. Brito[1,*], Bjørg Heringstad[2], Ilka Klaas[3], Katharina Schodl[4], Victor E. Cabrera[5], Anna Stygar[6], Michael Iwersen[7], Marie J. Haskell[8], Friederike Katharina Stock[9], Nicolas Gengler[10], Jeffrey Bewley[11], Miel Hostens[12], Elsa Vasseur[13], Christa Egger-Danner[4]

ICAR

FIL IDF Fédération Internationale du Lait · International Dairy Federation ·

EAAP SESSION 83

Future developments / Outlook

- **Animal health / welfare of increased importance –** consumer demands, sustainability
- **Many new traits of interest in the future – broader breeding goal ?!**
  - example AUSTRIA: metabolism, feed efficiency, methane?, calves / heifers related traits (health, behaviour, ..), resilience, heat stress
- **New possibilities due to digitalisation, artificial intelligence**
  - partly higher heritabilities expected
  - correlation to longevity?!
- **TMI - only 100% to share – pressure on other existing traits like longevity / review**
  - detailed studies on optimisation for different populations and circumstances (available phenotypes,..) needed – breed planing (genetic gain, costs, ..)
- **Expectation:** genetic gain for longevity related traits can be maintaind or increased even if the weight for the direct trait longevity will decrease

Take home message

- **Longevity important as ever** – shift from pure functional traits perspective to broader view related to sustainability
- **Economic and animal welfare – improve longevity - reach about 5 lactations**
- Longevity - **many influencing factors beside genetics and availability late in life – challenge genetics**!
- **Breeding goal / TMI – functional longevity important trait related to functionality**
- **High positive genetic correlation with direct health traits** – „substitute“ for direct health traits especially when direct phenotypes are rare – might reduce weight in TMI if relevant direct phenotypes are available in good quality and quantity
- **Continuous research and development** is important (traits, methods,..)
- **Optimisation at all levels** (phenotyping, breeding, management, ..)

Acknowledgement

- The presentation is based on the collaborative work and presentations from the Rinderzucht AUSTRIA workshop on **Longevity – a traditional concept with a future?!** (http://rinderzucht.at/downloads/seminarunterlagen.html). Thank you to all my co-authors and contributors to this presentation.
- I would like to acknowledge the **continuous support and valuable contributions of farmers, veterinarians, claw trimmers, DHI and breeding organisations, research partners, business partners and along the dairy value chain and funding organisations**, who have worked together with us / supported us to promote and further develop cattle farming in Austria and internationally.

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ZUCHT DATA

GMON

Efficient Cow

ADDA

KLAUEN-Q-WOHL

FoKUHs

D4Dairy

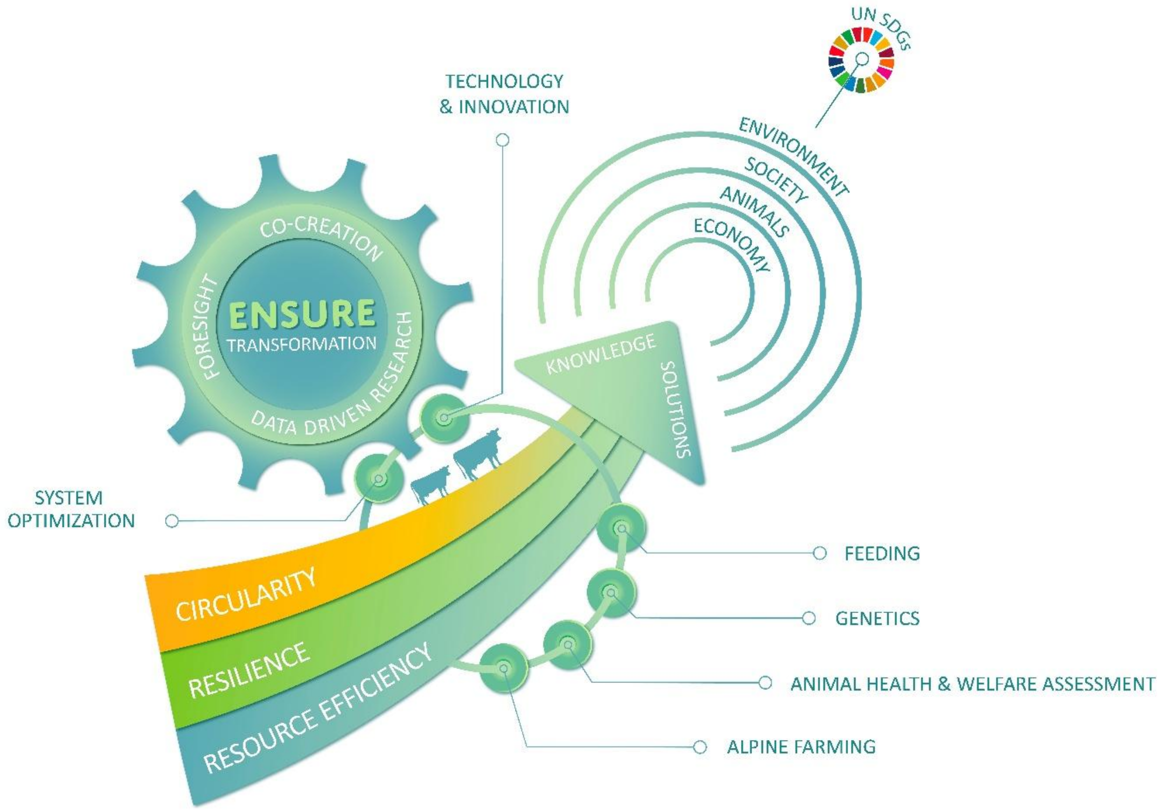
PROJEKT NEU.rind Nachhaltigkeit • Effizienz • Umweltwirkung

breed4green

FOKUHS HERDE

ENSURE

Data driven strategies to enhance sustainability, resilience, and resource efficiency of cattle farming



- COMET-project "ENSURE"
- Consortium of top scientists and key stakeholders
- 48 organizations across the beef and dairy value chains
- Duration: 1.11.2025-30.04.2029
- Budget: 4,936,190 €

Consortium

Research partners:

Company partners:

ENSURE is supported by:

Bundesministerium Wirtschaft, Energie und Tourismus

Bundesministerium Innovation, Mobilität und Infrastruktur

COMET - Competence Centers for Excellent Technologies

Consortium leader:

ZuchtData EDV-Dienstleistungen GmbH, ensure@zuchtdata.at, www.ensure-comet.com