Luke
NATURAL RESOURCES
INSTITUTE FINLAND

Cattle and Climate

Researcher, PhD Terhi Mehtiö

NÖK-seminar 25.7.2022

Terhi Mehtiö

Outline

- **Greenhouse gas (GHG) emissions of dairy cattle**
  - Global food production
  - Livestock emissions by region
  - Where do the GHG emissions come from and how they affect climate?
- **How can we mitigate the emissions in milk and beef production?**
  - Animal breeding and genetics
  - Animal nutrition
  - Management
- **Focus on sustainable cattle production**
  - Goals for the future cattle production
- **Wrap up**

Luke ©NATURAL RESOURCES INSTITUTE FINLAND

Greenhouse gas emissions of cattle

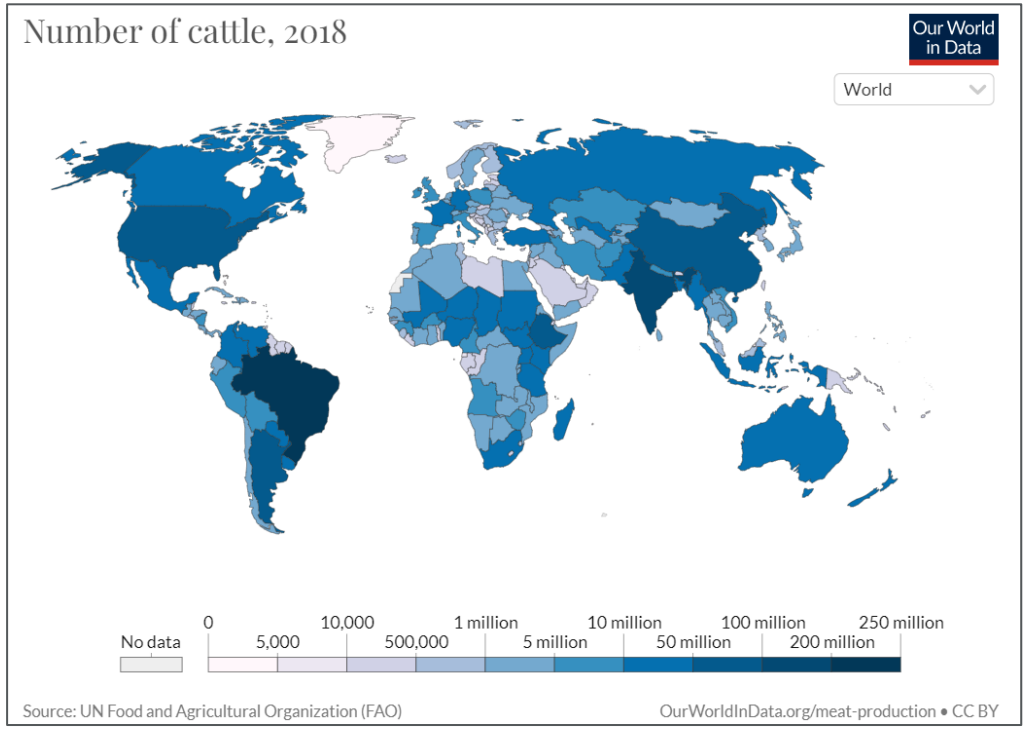
©NATURAL RESOURCES INSTITUTE FINLAND

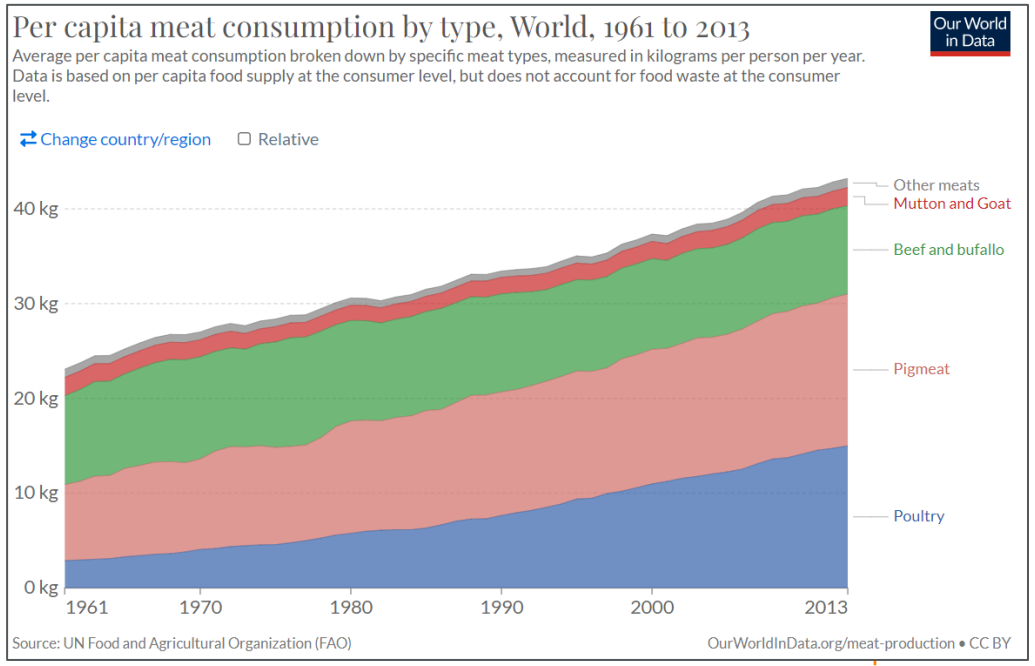
Global food production

- The global food system is responsible for:
  - about ¼ of all human-induced GHG emissions,
  - about 1/3 of global terrestrial acidification,
  - majority of global eutrophication,
  - occupying 40% of the world's ice- and desert-free land (van Selm et al., 2018)

- The world now produces more than 3 times the quantity of meat as it did 50 years ago (ourworldindata.org)

- Additional increase of more than 50% of food is expected by 2050 to meet projected increases in demand

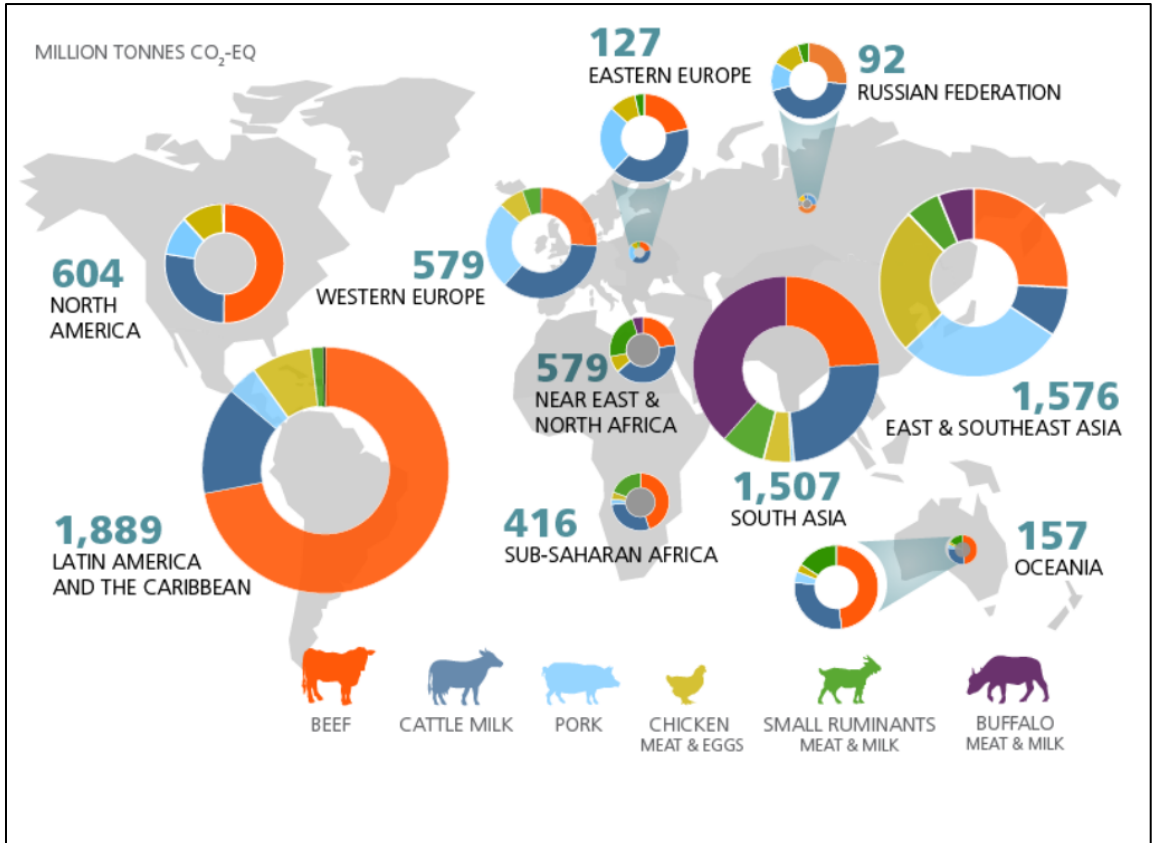




Luke © NATURAL RESOURCES INSTITUTE FINLAND

Livestock emissions by region

- Regional emissions and production figures vary widely
  - Differences explained by variations on the share of ruminant and monogastric species and emission intensities
- Highest level of emissions in Latin America and the Caribbean caused by the specialized production of beef
  - High CO_2 emissions arising from deforestation and pasture expansion
- Second highest emitting region is East & Southeast Asia, and then South Asia
  - East and Southeast Asia is the region with the highest production, but mainly driven by monogastic species
- North America and Western Europe show similar levels of emissions and production
- Near East and North Africa, Eastern Europe, Oceania and Russian Federation have a very low production level and lower emission levels



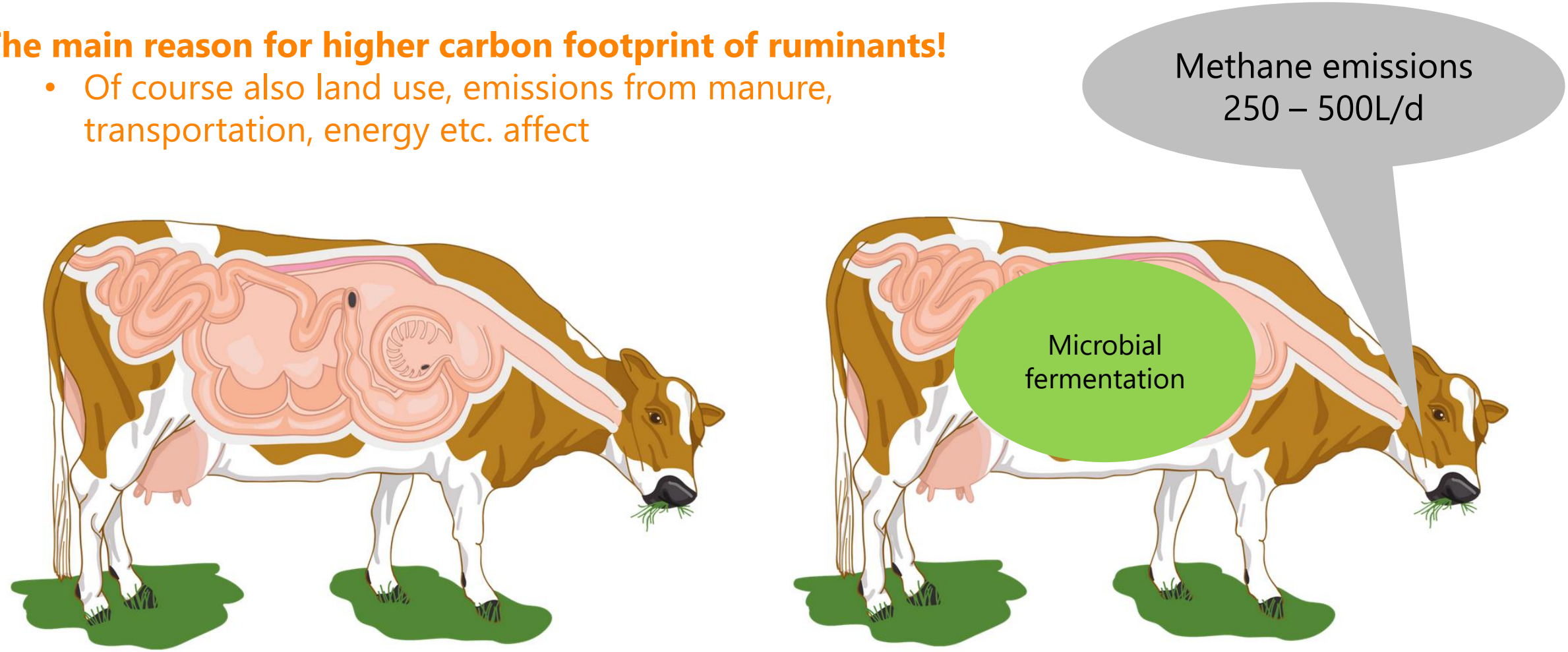
***Regional emissions**. Regional total emissions and their profile by commodity are shown. Results do not include emissions allocated to non-edible products and other services.*

https://www.fao.org/gleam/results/en/

Methane from enteric fermentation

The main reason for higher carbon footprint of ruminants!

- Of course also land use, emissions from manure, transportation, energy etc. affect



Methane from enteric fermentation

The uniqueness of ruminants – they can utilize fibre-rich grass and convert it to nutritious human-edible milk and meat

Aerobic fermentation

$$\text{Glucose} + O_2 \longrightarrow ATP + CO_2 + H_2O$$

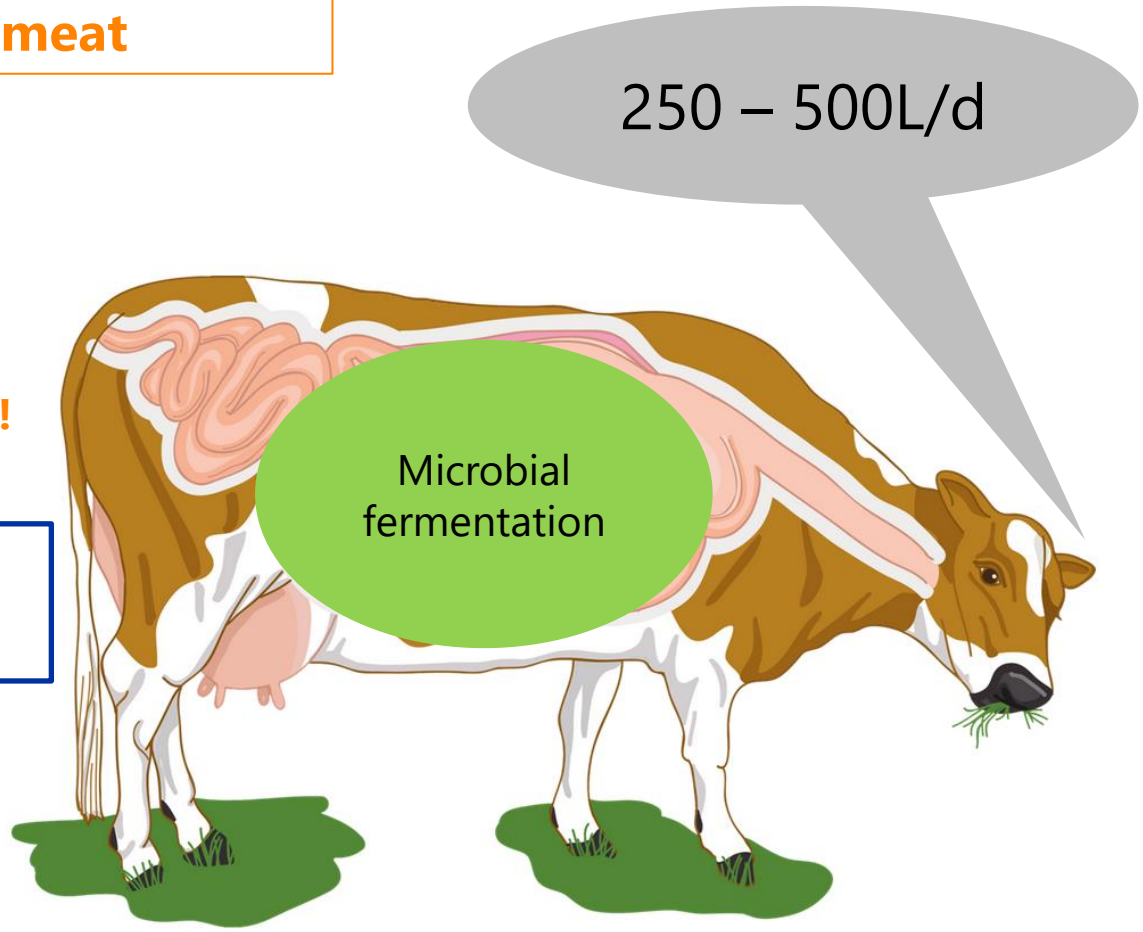
Anaerobic fermentation

Volatile fatty acids used by the cow!

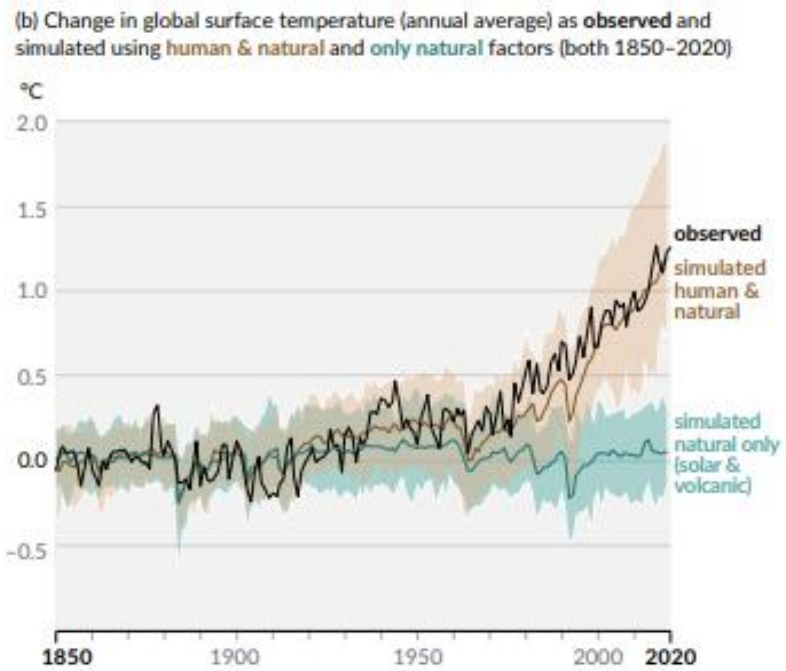
$$\text{Glucose} \longrightarrow \text{acetic acid} + \text{propionic acid} + \text{butyric acid} + CO_2 + H_2 + \text{Energy}$$

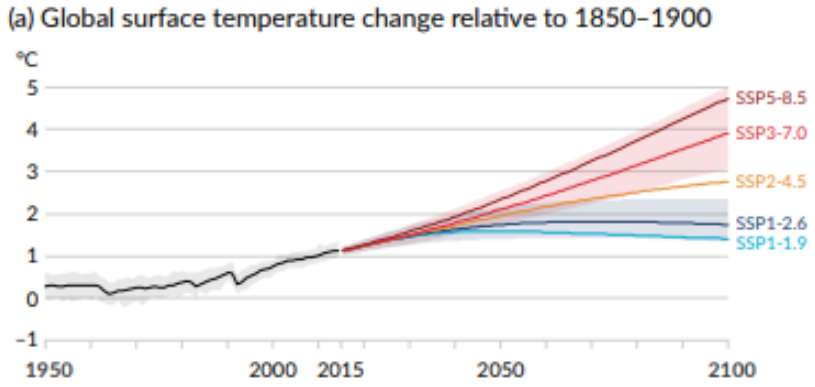
$$CO_2 + 4H_2 = \mathbf{CH_4} + 2H_2O$$

Methane belched out!



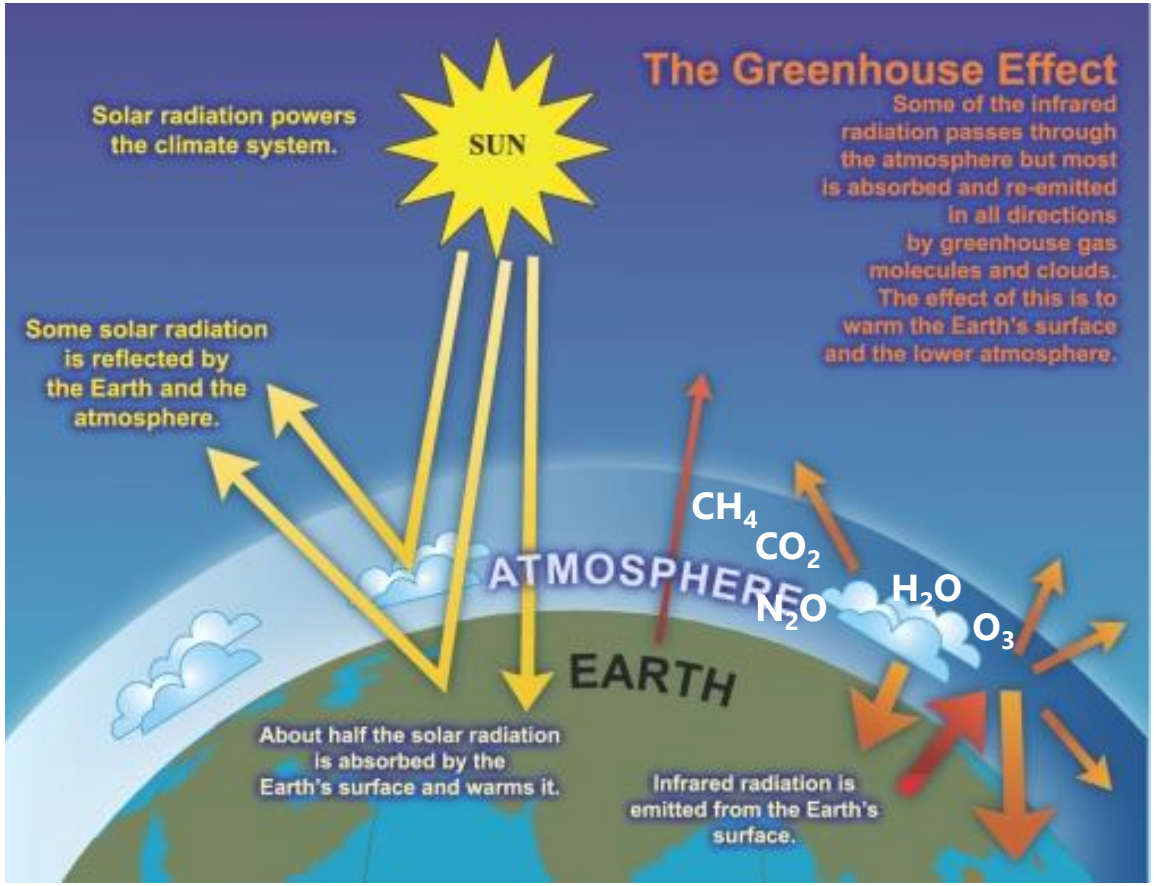
Human-induced climate change





https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

Human-induced climate change is causing dangerous and widespread disruption in nature and affecting the lives of billions of people around the world - Urgent action is required from <u>all sectors</u>!



https://climate-woodlands.extension.org/enhanced-greenhouse-gas-effect/

© NATURAL RESOURCES INSTITUTE FINLAND

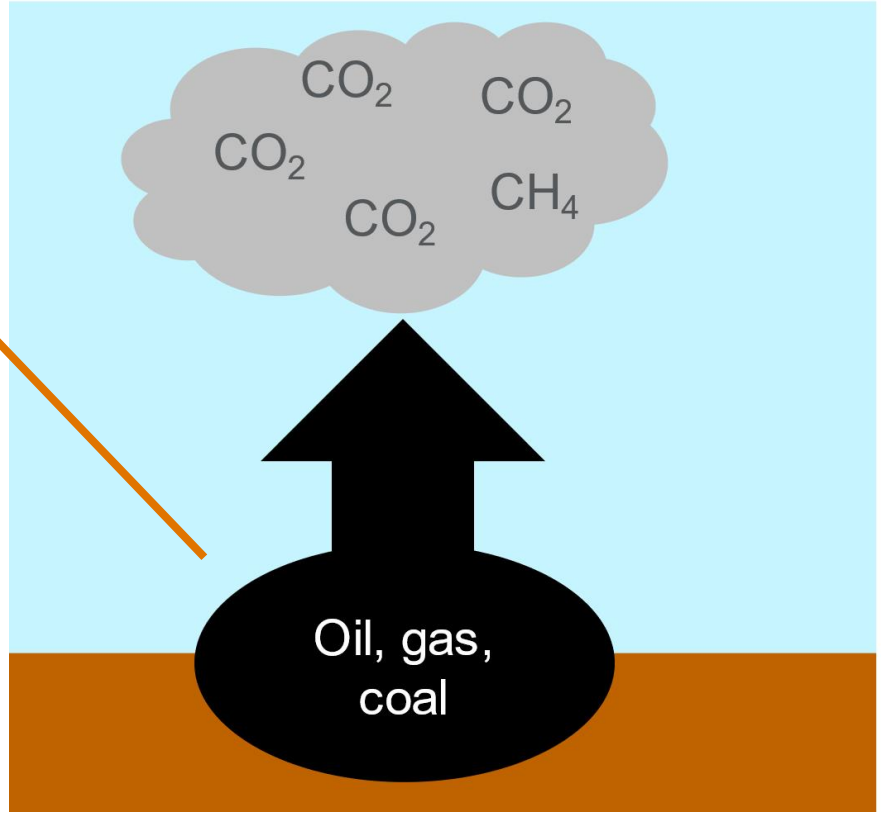
Food for thought:
Carbon – does it matter if it is originated from fossil or biogenic?

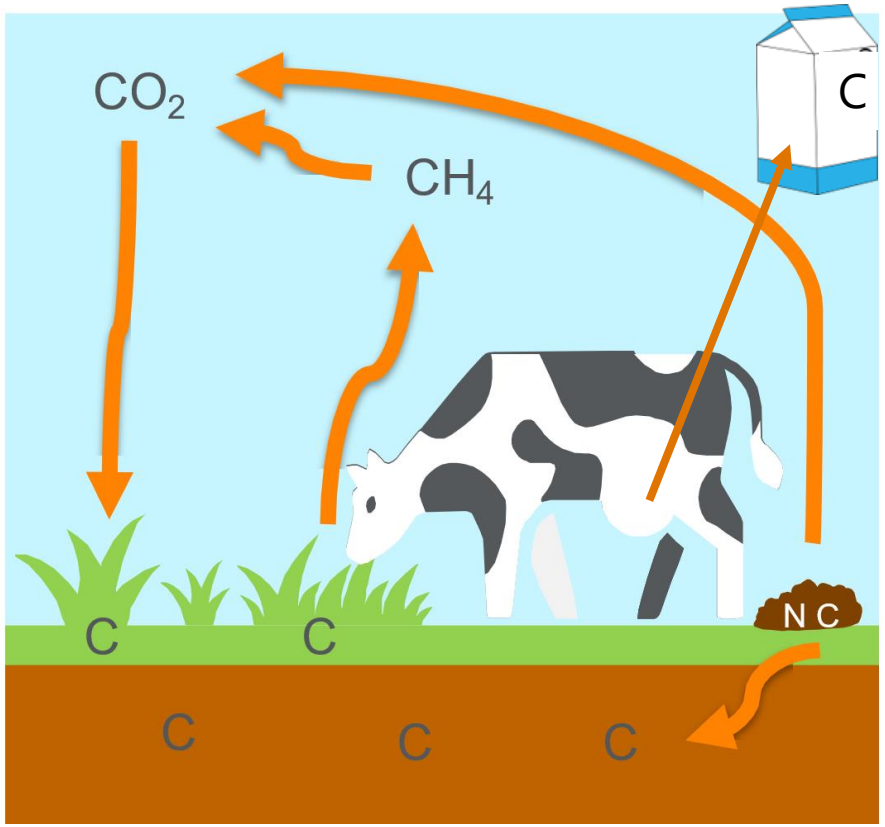
Fossil carbon, stored in the ground during ages and not renewing, is digged and released to atmosphere

vs.

Biogenic carbon is recycling

The most important source of emissions!





Picture: Prof. Marketta Rinne, Luke

Luke ©NATURAL RESOURCES INSTITUTE FINLAND

How can we mitigate GHG emissions in milk and beef production?

Luke ©NATURAL RESOURCES INSTITUTE FINLAND

We have already decreased emissions!

Case Finland

During years 1965-2020 the total CH_4 production has decreased 56%

→ result of the increase in productivity of the cows and decrease in no of animals (Huhtanen et al. 2022)

AGRICULTURAL AND FOOD SCIENCE

Agricultural and Food Science (2022) 31: 1–11

https://doi.org/10.23986/afsci.113752

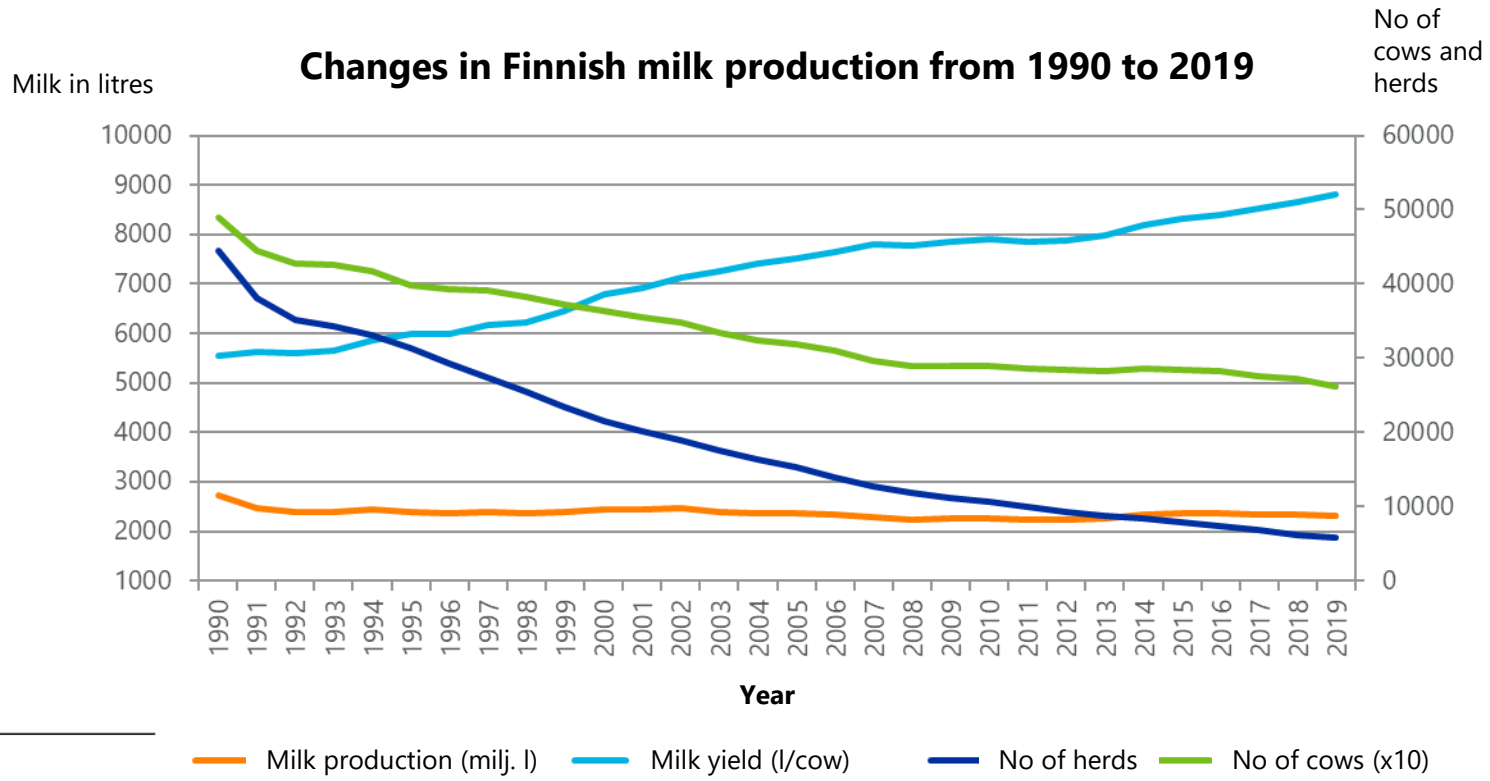
Methane production inventory between 1960–2020 in the Finnish dairy sector and the future mitigation scenarios

Pekka Huhtanen[1], Aleksi Astaptsev[2] and Juha Nousiainen[2]

[1]Production Systems, Natural Resources Institute Finland (LUKE), 31600 Jokioinen, Finland

[2]Valio Ltd. P.O. Box 10, FI-00039 Valio, Finland

e-mail: pekka.huhtanen@luke.fi



Source: Luke statistics (https://statdb.luke.fi/PXWeb/pxweb/fi/LUKE/)

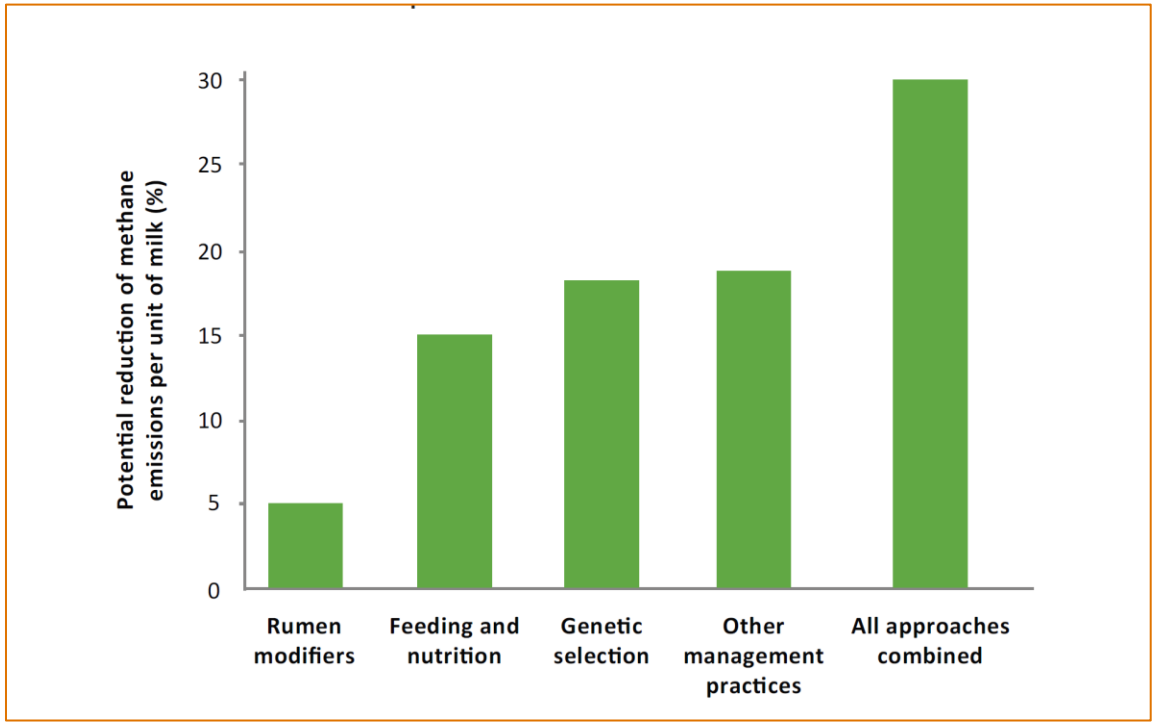
Three most important ways to further mitigate GHG emissions

1) Herd management
2) Animal breeding and genetics
3) Animal nutrition

And the best way is to combine all approaches and improve

- Feed efficiency
- Health and welfare
- Fertility
- Productivity

Possibility to decrease even 30% of CH_4 per unit of milk (Knapp et al., 2014)



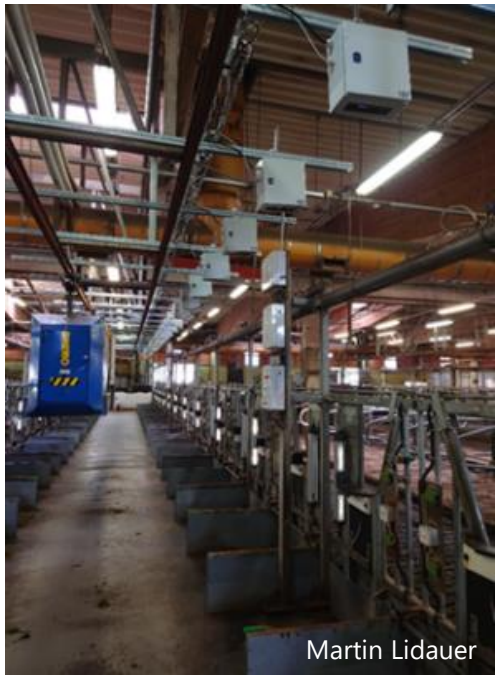
Animal breeding and genetics

Improving feed efficiency:

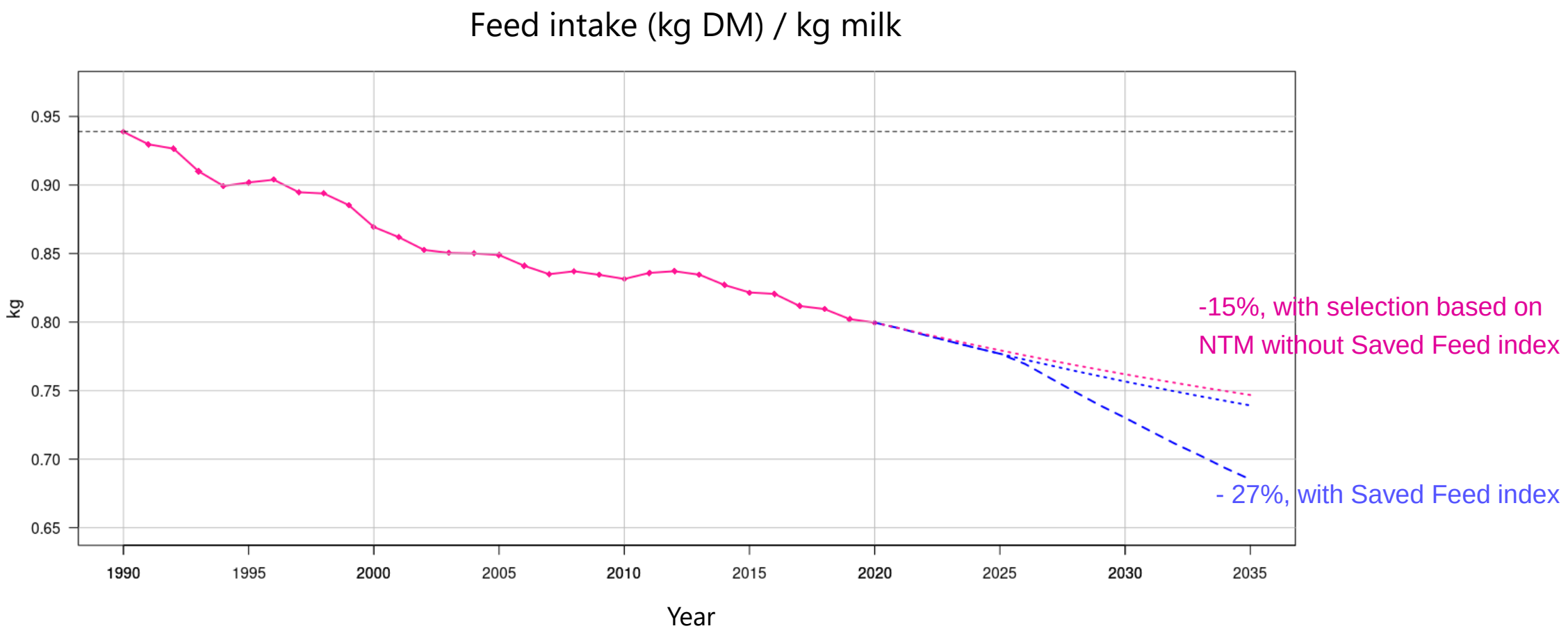
Saved Feed –index was included in Nordic Total Merit –index in 2020

- Still a challenge – measuring of feed intake (data from research farms)
  →Low reliability of genomic breeding values
- Development in collaboration between NAV, VikingGenetics, Luke, Århus University, Seges and Växa Sverige
- Consists of two sub-indeces:
  1) Maintenance (based on the body weight of the cow)
  2) Metabolic efficiency (residual feed intake)
- More information can be found:
  - NAV: https://nordicebv.info/saved-feed/
  - VikingGenetics: https://www.vikinggenetics.com/news/optimise-feed-efficiency-with-the-saved-feed-index

Terhi Mehtiö


Martin Lidauer

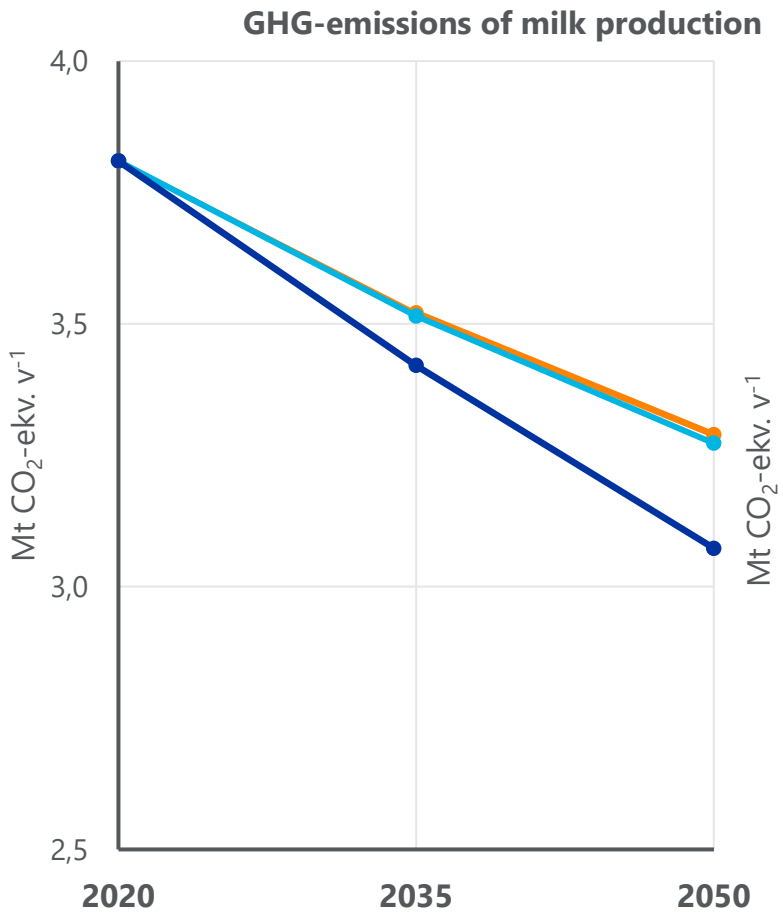
How much we are expecting to improve feed efficiency?

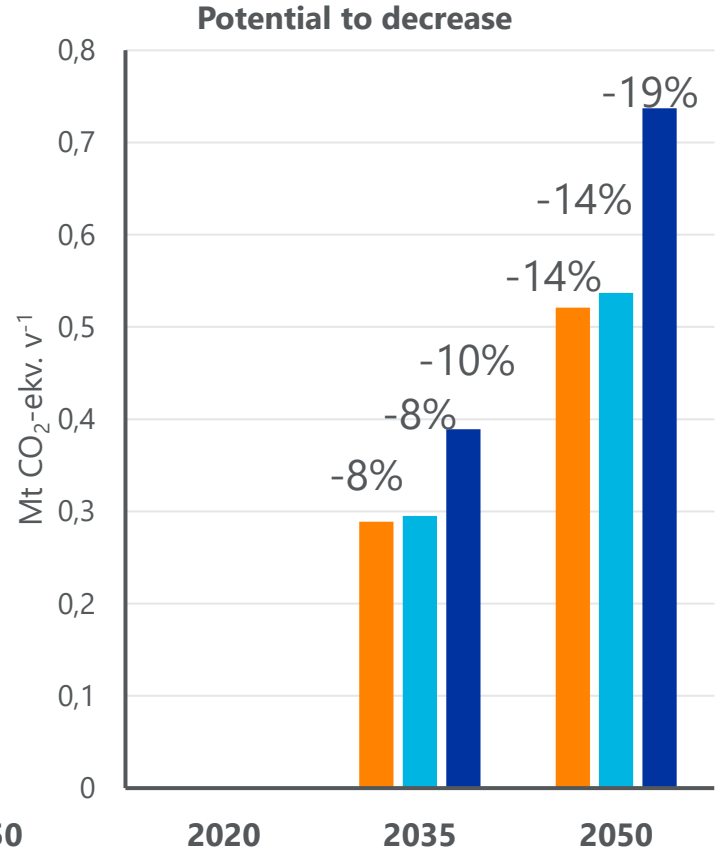


Source: Presentation by M. Lidauer, Luke, 2020

Luke ©NATURAL RESOURCES INSTITUTE FINLAND

How much could we decrease the emissions?





Scenarios

WEM: Current breeding program (N=200)

WAM1: More feed intake records from research herds (N=800)

WAM2: Feed intake measured on 20 large herds (N=6000)

More feed intake records for reference population

→ more reliable genomic breeding values

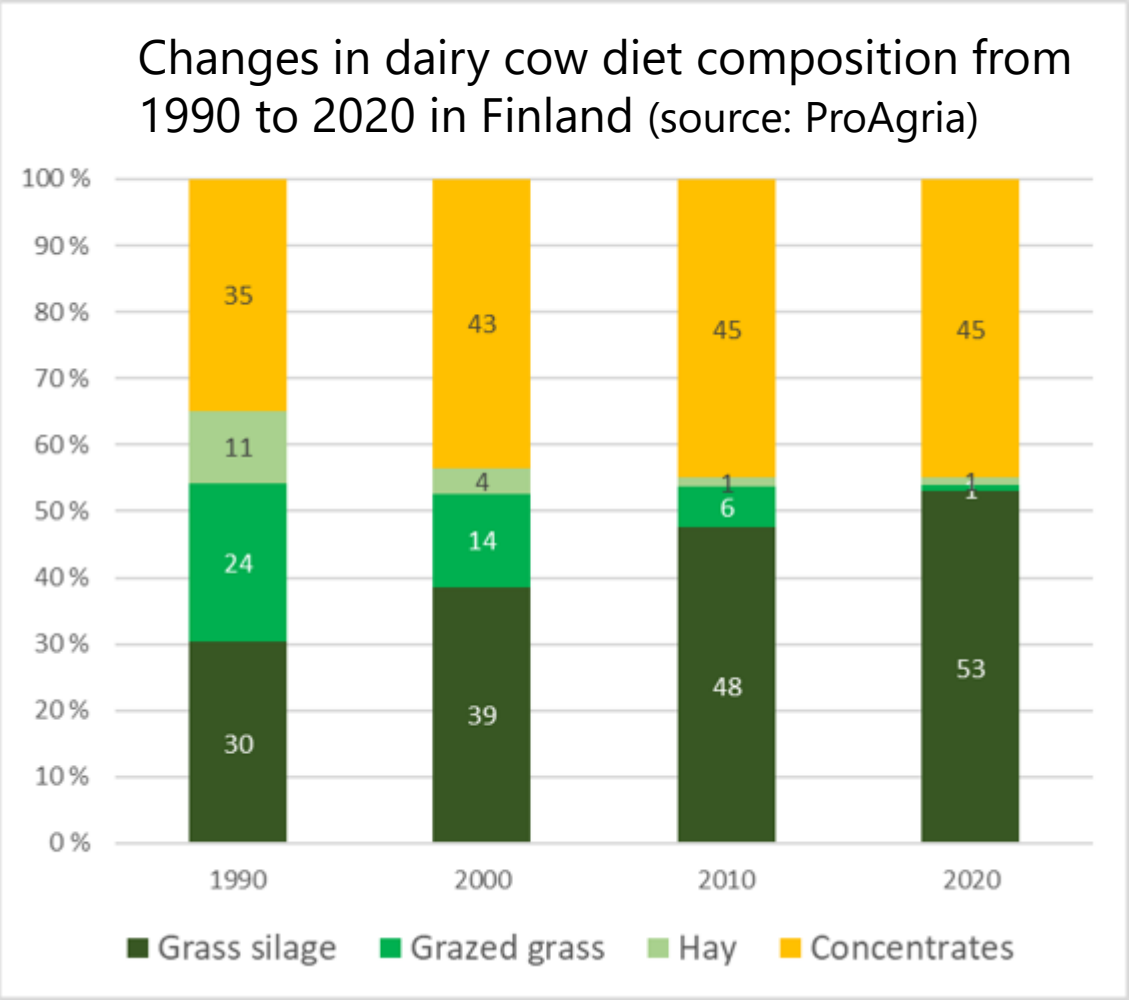
→ more efficient breeding program

Costs from measuring, but also **savings** from feeding costs!

Ahvenjärvi et al. 2022.

Animal nutrition

- Optimized feeding
  - In future more forage-based feeding?
- Use of by-products in feeding
- Novel feed additives to decrease methane emissions (oils, seaweeds, 3-NOP)
  - Still expensive



Luke ©NATURAL RESOURCES INSTITUTE FINLAND

Herd management

- Minimum waste in the whole production chain!
- Optimal and smart decisions by the farmer in i.e. reproduction, health and welfare and renewing of the animals
    - Less emissions from long living and long producing animals
- Other solutions of smart farming
    - Circular economy
    - Feces storage and nutrient recycling
    - Renewable energy
    - Smart use of land
    - Grass and possibilities for carbon sequestration

Luke ©NATURAL RESOURCES INSTITUTE FINLAND

Focus on sustainable cattle production

Luke ©NATURAL RESOURCES INSTITUTE FINLAND

Food production, and food security, comes always with a cost

- We need to produce more nutritious and good quality food in the future,
- We must mitigate climate change,
- And at the same time, climate change and other crises will deteriorate the possibilities for farming

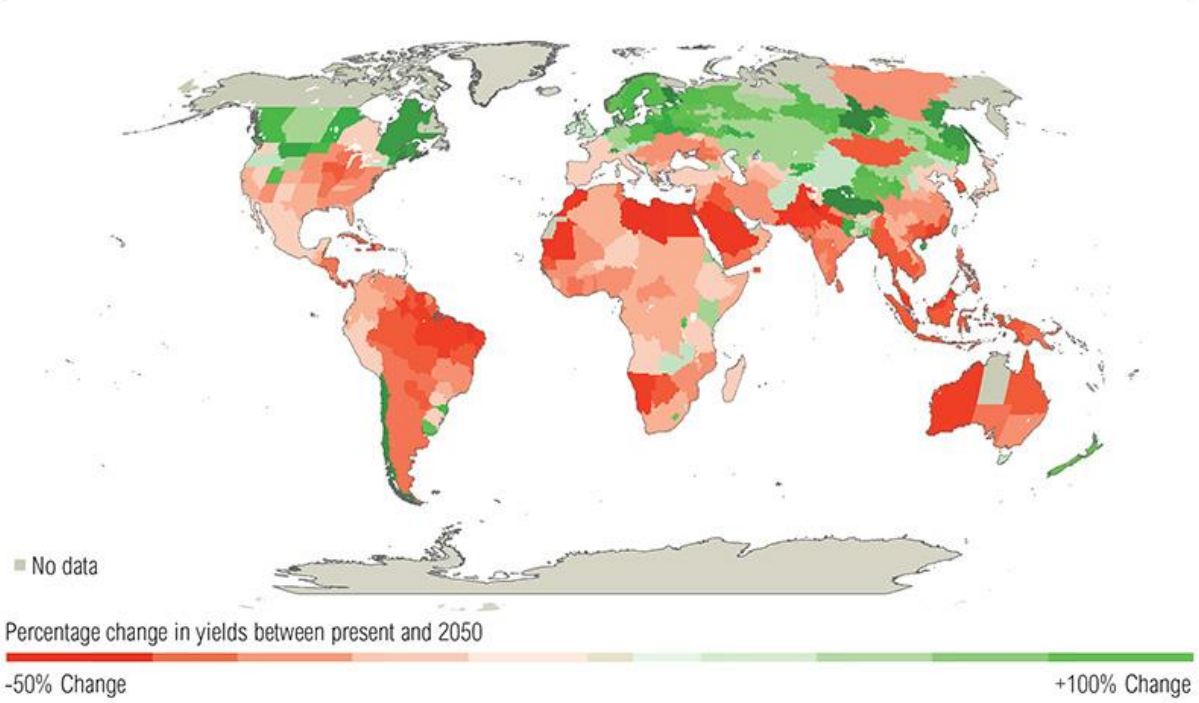
Global Consumption of Meat and Milk Products

REGION	LIVESTOCK (KCAL/PERSON/DAY)			BEEF AND MUTTON (KCAL/PERSON/DAY)		
	2006	2050	% CHANGE	2006	2050	% CHANGE
European Union	864	925	7%	80	75	-6%
Canada & USA	907	887	-2%	117	95	-19%
China	561	820	46%	41	89	116%
Brazil	606	803	33%	151	173	15%
Former Soviet Union	601	768	28%	118	156	32%
Other OECD	529	674	27%	64	84	31%
Latin America (ex. Brazil)	475	628	32%	59	86	45%
Middle East and North Africa	303	416	37%	59	86	45%
Asia (ex. China, India)	233	400	72%	24	43	79%
India	184	357	94%	8	19	138%
Sub-Saharan Africa	144	185	29%	41	51	26%
World	**413**	**506**	**23%**	**50**	**65**	**30%**

WORLD RESOURCES INSTITUTE

Sources: http://ow.ly/rpfMN

Most studies now project adverse impacts on crop yields due to climate change (3°C warmer world)



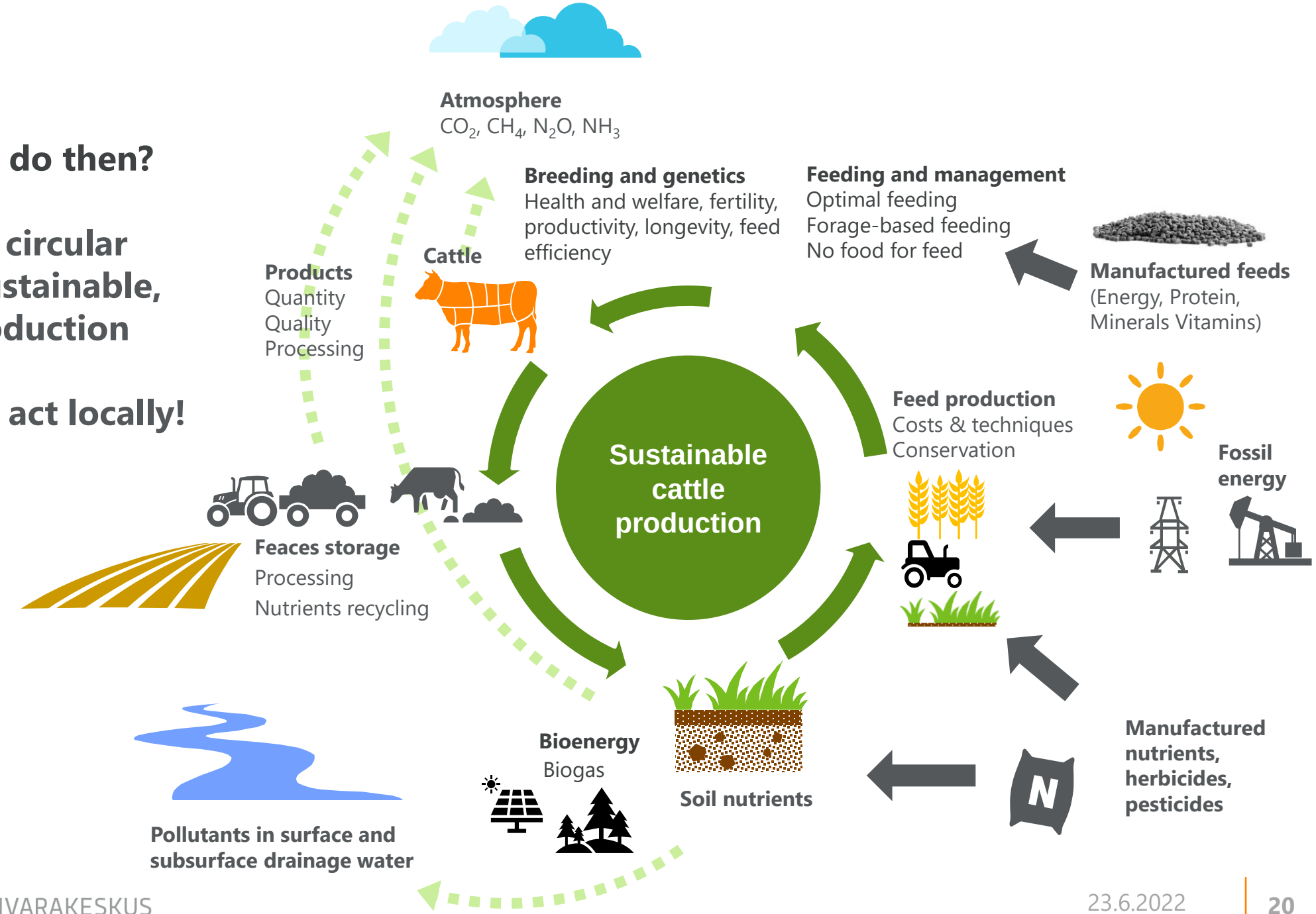
WORLD RESOURCES INSTITUTE

Sources: http://ow.ly/rpfMN

What should we do then?

- More focus on circular economy and sustainable, but efficient production

- Think globally, act locally!



Green lines= Biogenic carbon cycle

Dashed lines = Potential emissions

Grey lines= External inputs that should be minimised

Goals for the future cattle production

Cattle production is aiming to be

1. part of the **nutritious, healthy and safe diet**,
2. part of the **self-sufficient food production** and supports food supply security,
3. based on **circular bioeconomy**,
4. **sustainable** in terms of climate change and environment,
5. Increasing **biodiversity**,
6. **Economically sustainable** and competitive,
7. Ensuring **animal welfare and health**, and
8. **acceptable and responsible**.

Wrap up

©NATURAL RESOURCES INSTITUTE FINLAND

Wrap up

- Globally, the requirement for food and also for milk and beef will increase
- We need to be smart in food production, think globally but act locally in most sustainable but efficient way
- Climate change is challenging us in many ways, and we have to work hard on mitigating GHG emissions in every sector
- There are possibilities and strengths in cattle production
  - Emissions can be decreased by animal breeding, nutrition and management
  - Cattle is essential for food production and food security based on circular economy
- More research and innovative solutions are needed in future – strong collaboration within the whole industry, farmers, and research is more important than ever!

Thank you!

Terhi Mehtiö

Luke ©NATURAL RESOURCES INSTITUTE FINLAND

Literature

Ahvenjärvi, S., Lehtonen, H., Lång, K., Lidauer, M., Mehtiö, T., Huhtanen, P., Nousiainen, J., Hietala, S., Bloch, V., Suomi, P., Lötjönen, T., Latukka, A., Kaukovirta, A., Tolvanen, A. 2022. Maatalouden kasvihuonekaasupäästöt ja niiden kustannukset. http://urn.fi/URN:ISBN:978-952-380-444-9

Huhtanen, P., Astaptsev, A., Nousiainen, J. 2022. Methane production inventory between 1960-2020 in the Finnish dairy sector and the future mitigation scenarios. *Agr and Food Sci* 31, 1-11. https://doi.org/10.23986/afsci.113752

Knapp J.R, Laur, G.L., Vadas, P.A., Weiss, W.P., Tricarico, J.M. 2014. Invited review: Enteric methane in dairy cattle production: Quantifying the opportunities and impact of reducing emissions. *J Dairy Sci* 97, 3231-3261. https://doi.org/10.3168/jds.2013-7234

van Selm, B., Frehner, A., de Boer, I.J.M. *et al.* 2022. Circularity in animal production requires a change in the EAT-Lancet diet in Europe. *Nat Food* 3, 66–73. https://doi.org/10.1038/s43016-021-00425-3