Silage and grassland management in Norway

Quality, yield and climate

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What do you associate with
Norway + Agriculture?

Latitude and size

Steinkjer: Approx 64 degrees north

Tallin: 59.437° N

Main objectives for the Norwegian agricultural politics

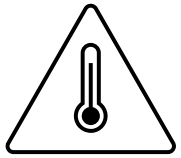
Food security and preparedness

Maintaining farming activities throughout the entire country

Increased value creation

Sustainable agriculture with low emissions of climate gases

Climate Norway and Estonia



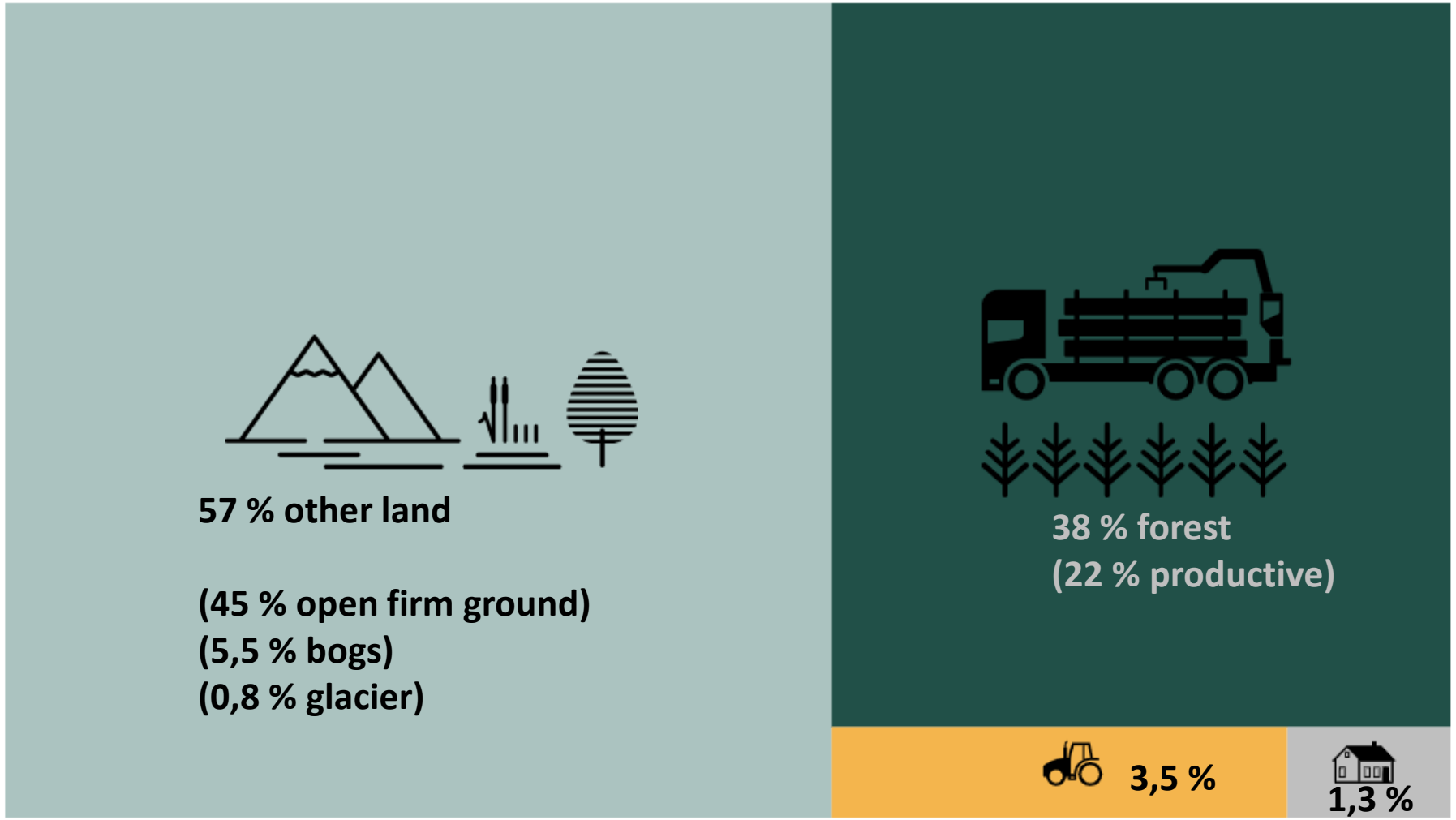
Tartu

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily mean °C (°F)	−4.1 (24.6)	−4.4 (24.1)	−0.5 (31.1)	5.9 (42.6)	11.5 (52.7)	15.5 (59.9)	18.0 (64.4)	16.7 (62.1)	11.8 (53.2)	6.0 (42.8)	1.2 (34.2)	−2.1 (28.2)	6.3 (43.3)
Steinkjer	−2.2	−2.3	0.1	4.3	8.8	12.5	15.2	14.5	10.5	5.0	1.0	-1.4	5,50
Stavanger	0,8	0,6	2,7	5,5	9,9	12,8	14,2	14,4	11,7	8,8	4,6	2,2	11,5

Tartu

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average precipitation mm (inches)	48 (1.9)	39 (1.5)	36 (1.4)	35 (1.4)	54 (2.1)	88 (3.5)	67 (2.6)	79 (3.1)	55 (2.2)	68 (2.7)	55 (2.2)	51 (2.0)	673 (26.5)
Steinkjer	90.8	72.1	74.2	48.9	48.4	59.9	70.8	76.3	82.6	85.4	76.9	93.3	900
Stavanger	92	66	75	50	68	91	115	156	114	148	136	110	1221

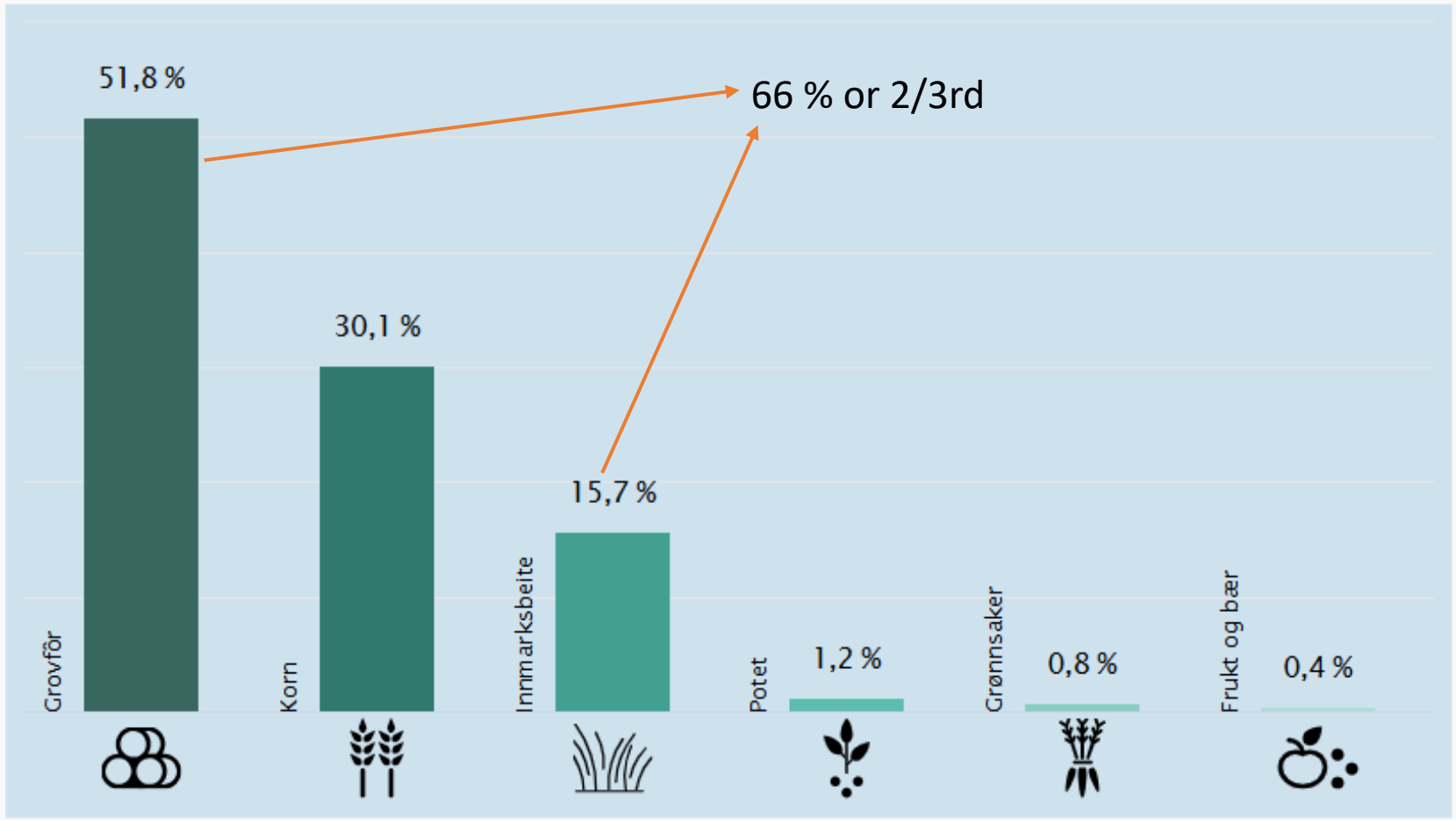
Norway - Land use and land cover

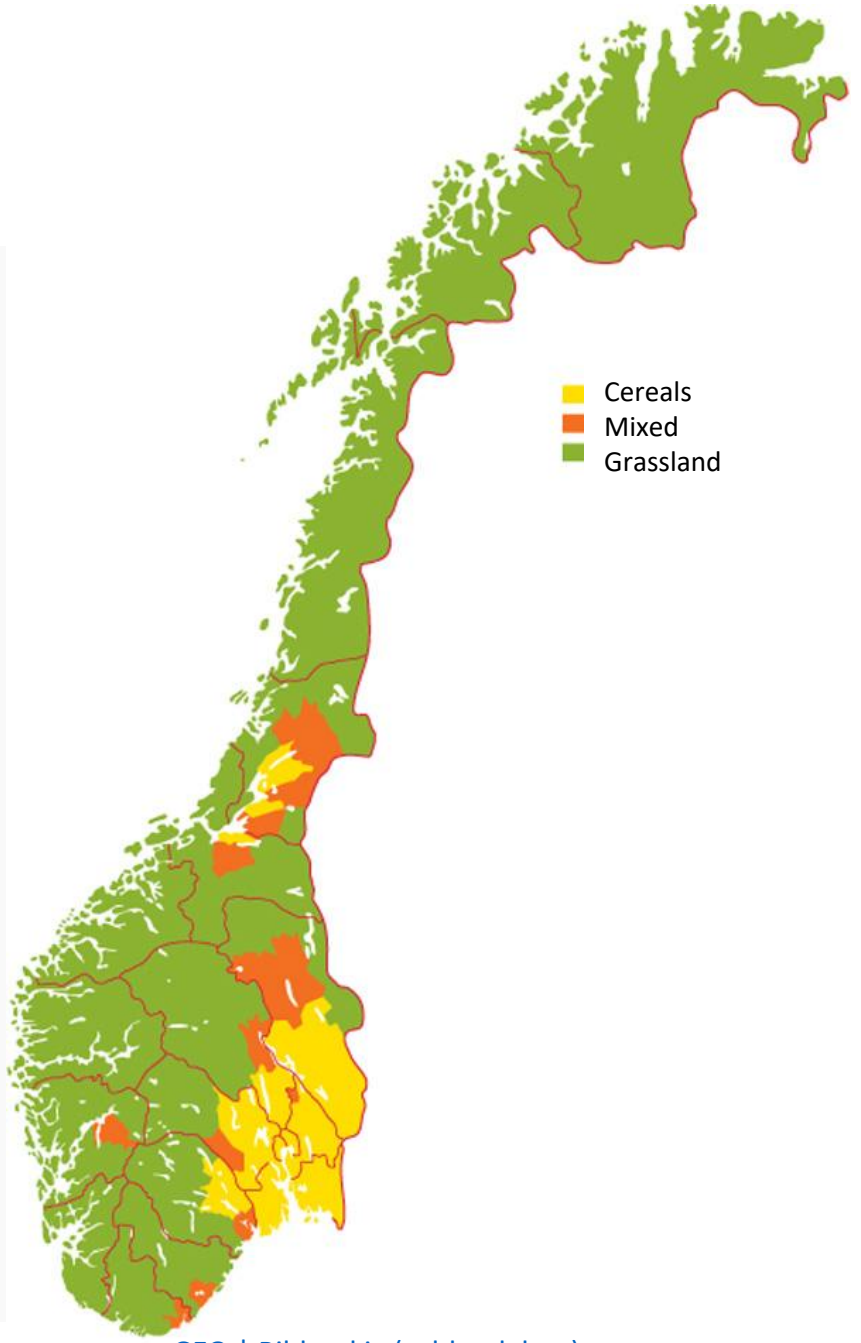


Estonia 2022: 23.08 %

www.nord.no

Norway = grass and silage





https://arealbarometer.nibio.no/nb/norge/

GEO | Bildearkiv (gyldendal.no)

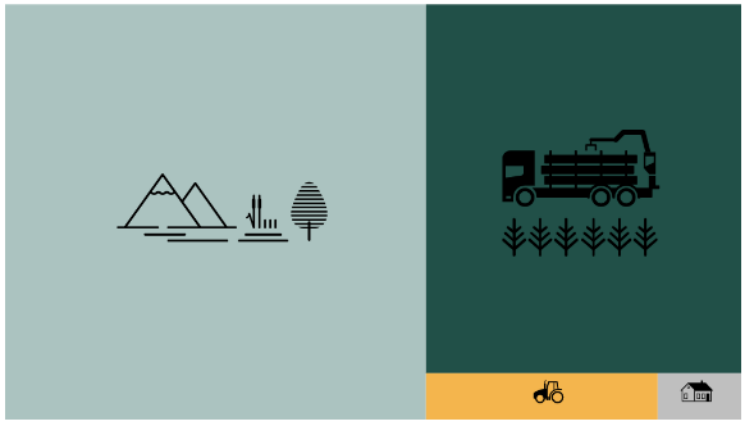
Rules and basis for agriculture in Norway

- Negotiations between state and farmers' organizations
  - Price, size of budget. Parliament approves
- Market regulation and tolls
  - Domestic food production (40-45%)
- Concession law – government controls who can get ownership, ensure use to food production.
  - Personal ownership of farms
- Allodial law – Farm owners oldest descendants' priority when farms are sold
  - Many family-owned farm

Rough grazing land/rangeland

- Farmed land 1,1 mill hectares (3,5 %)
- Farmable land 0,8 mill hectares (3,0 %)
- Rangeland 13,7 mill hectares (45,0 %)

Good or very good rangeland



Importance of rangeland

- Sheep farmer with rangeland pasture rights

40 % of forage/year

- Rangeland and grazing rights – prerequisite for sheep production in Norway

Fresvik, Sogn

Challenges in Norwegian plant production

- Climate changes – more extreme weather
  - Extreme rainfalls and draughts
  - More unstable and warmer winters
  - More plant diseases, insects (weeds)
  - Winter hardiness – milder winters
- Forage yield – do they actually know?
- Forage quality (too) stable
- Soil compaction
- Soil erosion – water

Norwegian Environment Agency (2025)

Sustainable silage management – how?

- Sustainability – get as much out of the resources used as possible.
  - Nutrients
  - Working time
  - Area
  - ……
- How can we ensure that?

How many of you know your grass yield?

What about Norwegian farmers? Do they know?

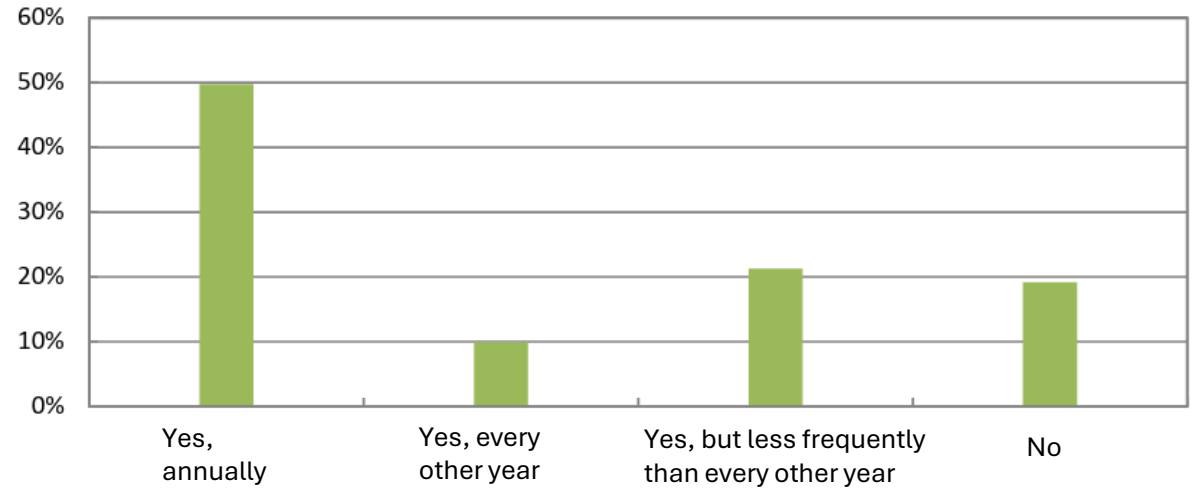
- 35 % say they dont know

AND

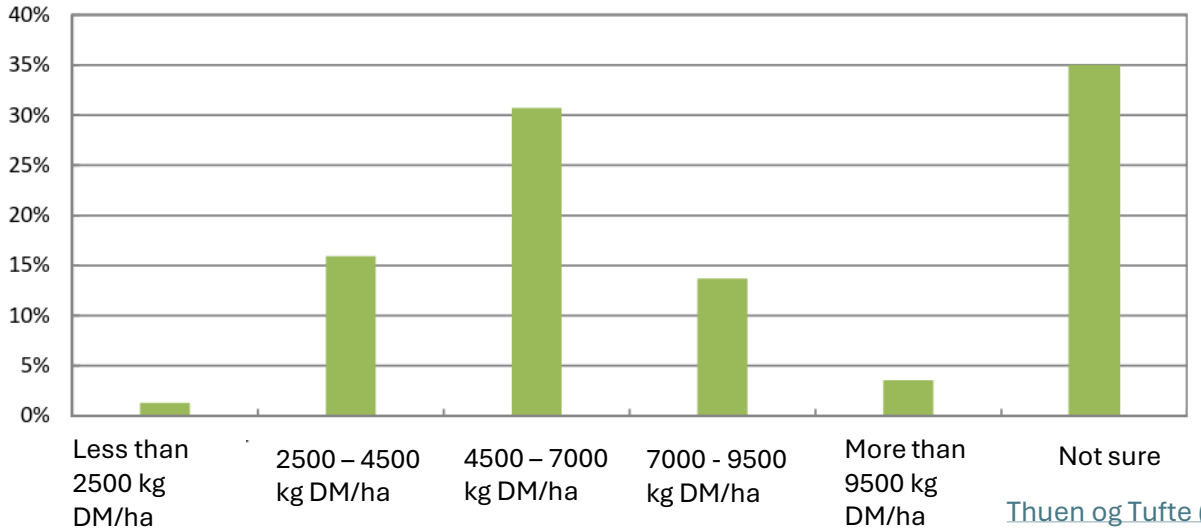
- 50 % say they don’t take forage samples/take them rarely.

How do they then know their yield?

Figur 3.1 Do you take forage samples? (n=2265)



Figur 2.2 What was avreage yield per ha last year? (n=2252)

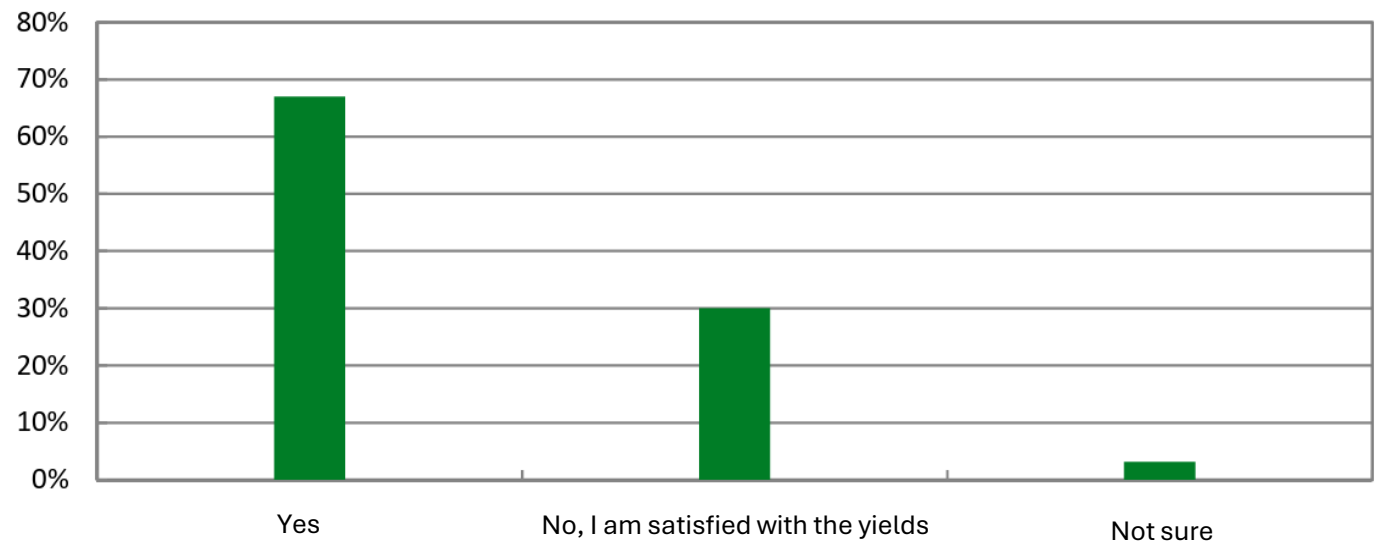


Thuen og Tufte (2017)

Do you want more silage?

- Yes, said Norwegian farmers.
- Start with knowing your yields
- Where is the starting point?

Figur 3.10 Is it a goal for you to increase your yield per hectar? (n=2218)



Thuen og Tufte (2017)

Measuring yield

- Weight and forage samples – pretty easy
- Forage wagon and forage samples – VERY easy.
  - 70 % of silage in Norway stored in roundbales.
  - Bunker siloes increasing.

- Ongoing - Develop models predict yield, quality, and winter damage. Spectral measurements and images from drones and satellites (Projects PRESIS and GrasSat (NIBIO)).
  - No concrete models ready
  - (Grasision (NIBIO and Ard Innovation))

Precision Agriculture (2021) 22:1437–1463
https://doi.org/10.1007/s11119-021-09790-2

Check for updates

Forage yield and quality estimation by means of UAV and hyperspectral imaging

J. Geipel[1] · A. K. Bakken[1] · M. Jørgensen[1] · A. Korsaeth[1]

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Sustainability – get as much out of the resources used as possible

Fertilizer – especially N, P
- N_2O leaching, run off

How to put up a good fertilizer plan when you don't know your yield?

Earlier fertilizer application?

++ yield first cut
+ total yield/year

Normally lowest CO_2 eqv./kg product

Steinshamn, Kvifte & Rivedal (2025)

What do you think when you encounter such numbers?

- What is the nutritional value of a kilogram?

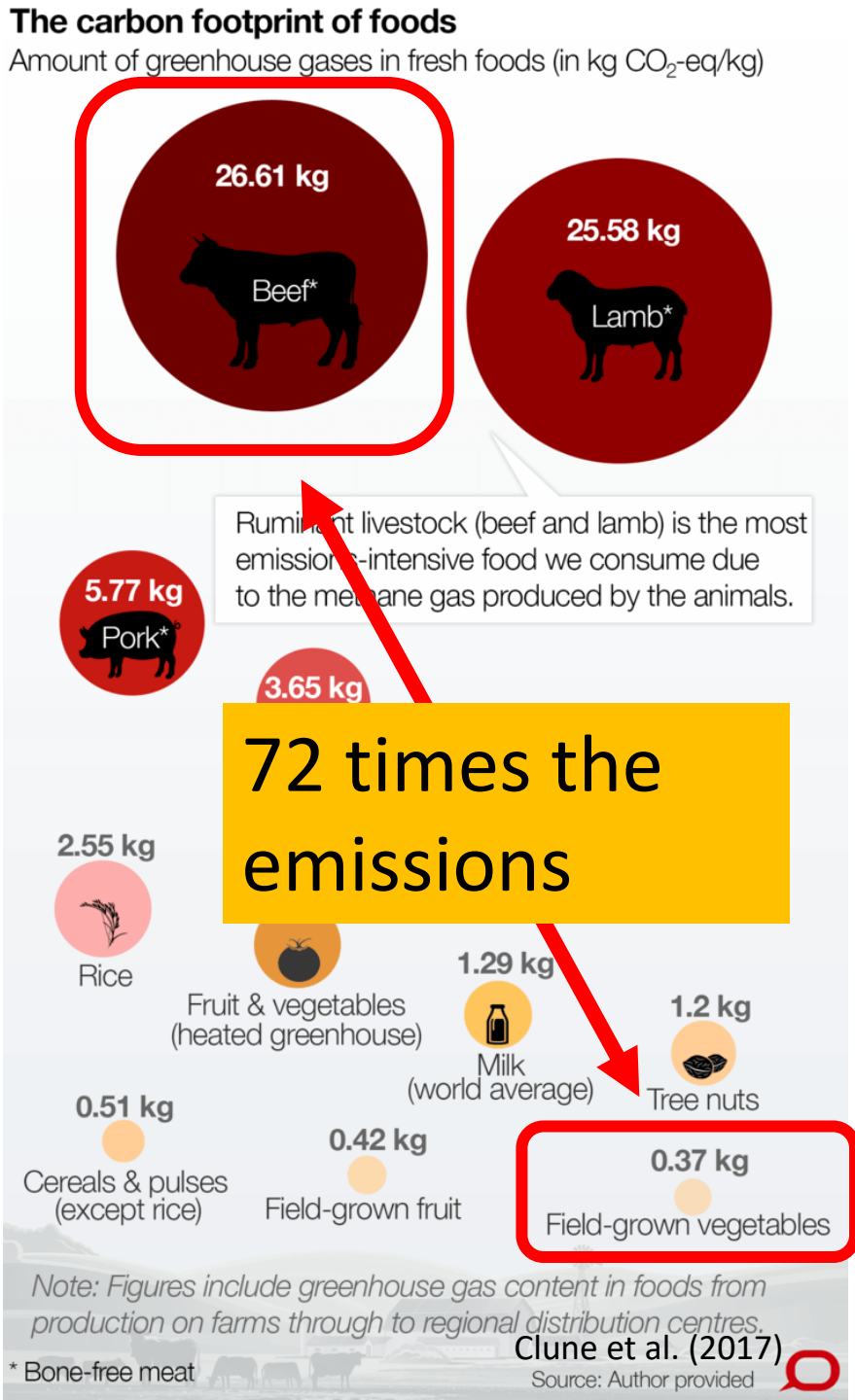
- 1 kg beef = 6,47 MJ
- 1 kg vegetable mix = 1,18 MJ
- Vitamins and minerals is also important.

Conversion to CO_2-ekv./MJ

- Beef = 4,11 kg CO_2-ekv./MJ
- Vegetable mix = 0,31 kg CO_2-ekv./MJ

New ratio: 13 times as much emissions

Values: https://www.matvaretabellen.no/ (Mattilsynet)



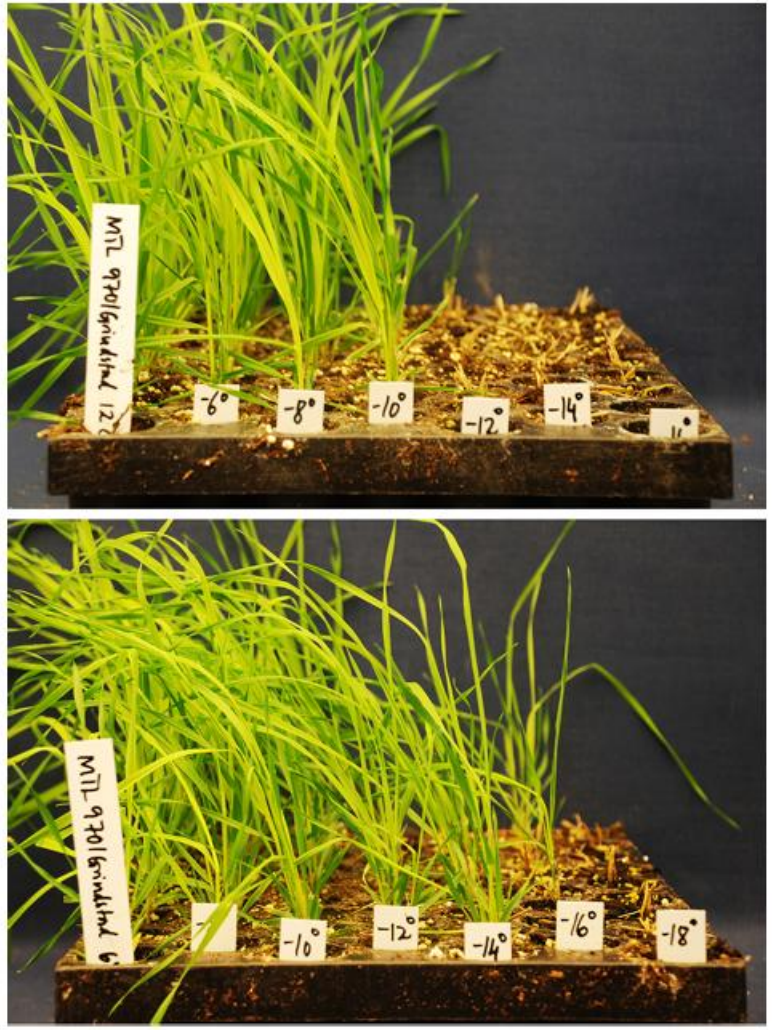
Higher digestibility of silage = less methane?

- Strong focus on methane in Norwegian agriculture
- Climate = sustainability?
- Bovaer – methane inhibitors the solution?
- Or higher digestibility of silage?
- Very little change in digestibility last 20 years. Why?
- Cost of more cuts, winterhardiness, highe forage intake = need for more silage. Do we have the area/potential?
- **Do we know the yield?**

Higher autumn temperatures

- Higher temperatures under pre-acclimation
  - Negative for acclimation and freezing tolerance?
- Tested good adapted grasses (timothy) and less adapted grasses (perennial ryegrass)

- Northern varieties (with higher freezing tolerance) more reduced freezing tolerance than more southern varieties.
- Red clover was less affected than grasses.



Figur 2 Grasplanter viste redusert frosttoleranse når dei vart dyrka ved høgre temperatur på seinsommaren; 12 °C (øvst) versus 6 °C. Foto: Leidulf Lund.

Østrem & Dalmansdottir (2022)

Dalmannsdottir m.fl. 2016

Reduced winter survival?

- **Winter stress:** freezing, waterlogged soil, ice cover, frost heaving, dessication (drying)
- Especially in Northern Norway.

- Trial: Field survivors vs original plant material
  - Survivors lower LT50 than the original material. Farmers confirm.

- Stress respons in older plants freezing stress
  - Elevated stress in surviving plants.
  - Higher expression of stress-responsive genes and oxidative stress

- Age effect?
- Cellular respiration – reducing sugar and carb reserves, energy intensive synthesis of proteins++.

Pashapu et al (2023)

TABLE 1 LT_{50} of plants from original seed lots and field survivors from two locations.

	Engmo	Noreng	Grindstad	Snorri
Original	−23.4 ± 0.6	−21.1 ± 0.8	−16.5 ± 0.7	−22.4 ± 0.6
Vesterålen	−16.3 ± 0.5	−15.5 ± 0.6	−13.8 ± 0.5	−13.8 ± 0.8
Tromsø	−16.8 ± 0.9	−15.8 ± 0.7	−16.3 ± 0.6	−17.0 ± 0.5

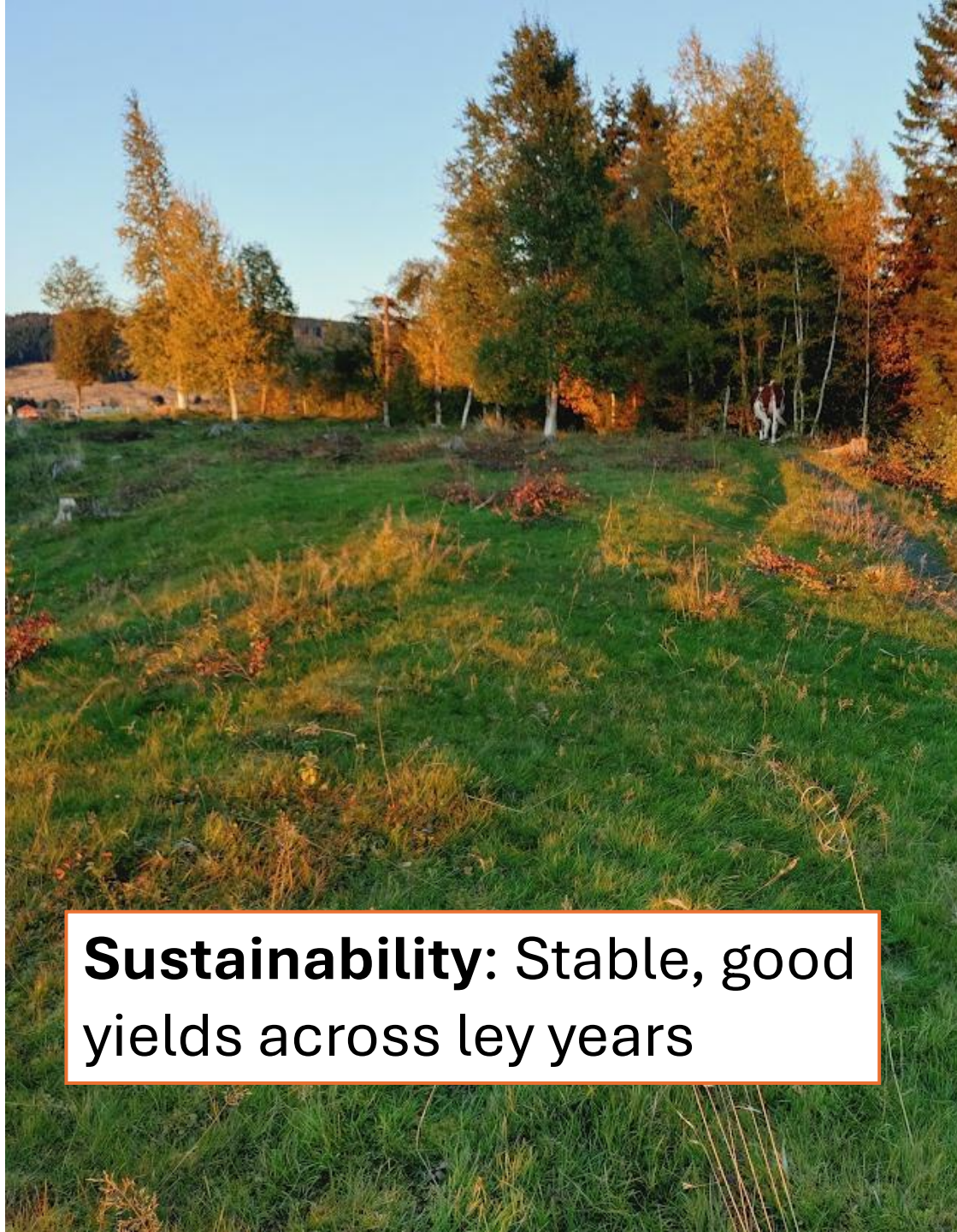
Will it move southwards?

Autumn temp and water

- **Dormancy signals**: Temperature + day length

- **Hardening & frost tolerance**
  – Warmer autumns = delayed hardening
  – Reduced light + high temp = weaker frost tolerance
  – Wetter autumns = affects hardening?
- *Low temp* + *wet soil* → better hardening
- *High temp* + *wet soil* → reduced tolerance
- **Climate adaptation challenge**
  – Adaption takes time
  – Now - rapid changes in autumn climate

Jørgensen et al (2019)

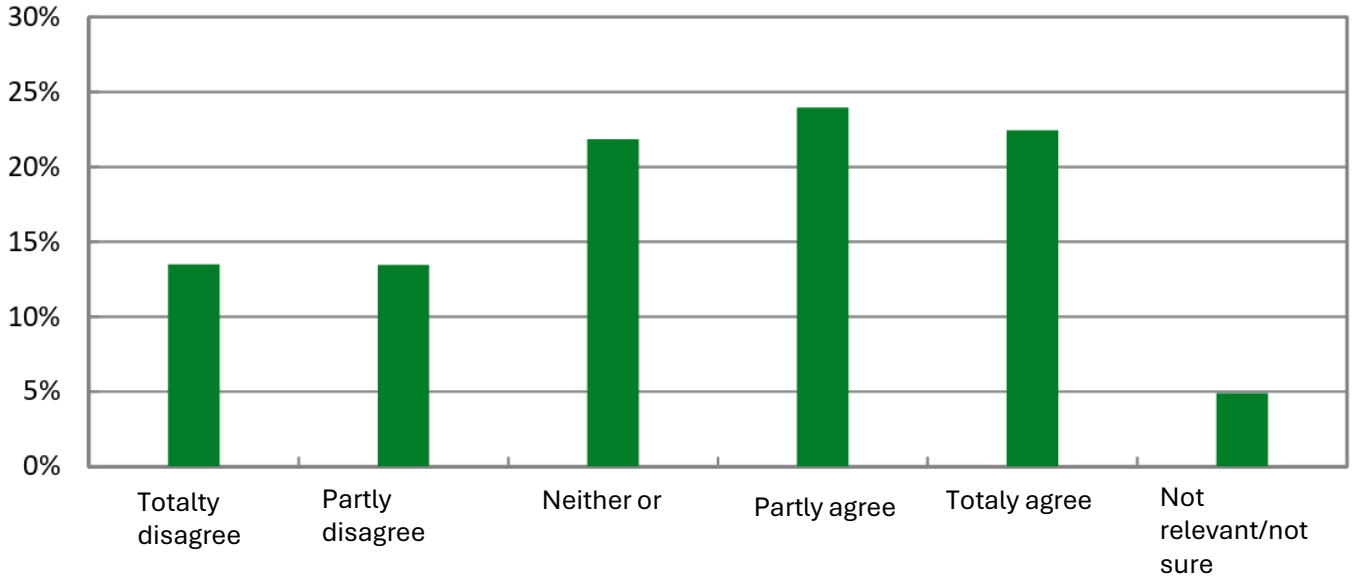


Sustainability: Stable, good yields across ley years

Figur 4.8 Better drainage on my land would have resulted in higher forage yields (n=2167)."

Water management

- An important key to sustainable silage



- Less soil compaction
- Traffic-induced plant damage
- Less N_2O
- Better hardening and frost tolerance
- Better yields – less CO_2 ekv/daa

Thank you for listening! Questions?