

Cows and climate

Contributions of grassland-based organic farming to more sustainable milk and meat production





Switzerland's grasslands are a key agricultural resource. They secure food supplies, provide important ecosystem services and contribute to climate mitigation. We use and preserve these grasslands with large and small ruminants. However, cattle are coming under increasing scrutiny: should their numbers be reduced or should their husbandry be intensified to protect the climate?

This publication highlights the need to preserve grasslands, the importance of organic cattle farming in the climate debate, and how agriculture can promote sustainable, future-proof animal husbandry.

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Why does it make sense to keep cattle on grassland?

Grasslands account for approximately two-thirds of the world’s agricultural land, including arid regions such as savannahs, steppes, and scrublands. The proportion is similar in Switzerland, where approximately 70 % of agricultural land consists of meadows and pastures. Arable land, on the other hand, is scarce, especially compared to other European countries.

Edible protein from grassland

Only ruminants, such as cattle, sheep, and goats, can make grasslands usable for human consumption. They convert plant protein from grasses, which humans cannot digest, into high-quality animal protein. This enables them to produce animal-based foods without the need for arable land. Milk and meat can thus be produced on grassland, alongside the production of plant-based foods on arable land.

Grass becomes food thanks to cows
Ruminants can make grassland usable for human consumption without requiring arable land.

Figure 1: Agricultural land in Switzerland^[37] and globally^[1]

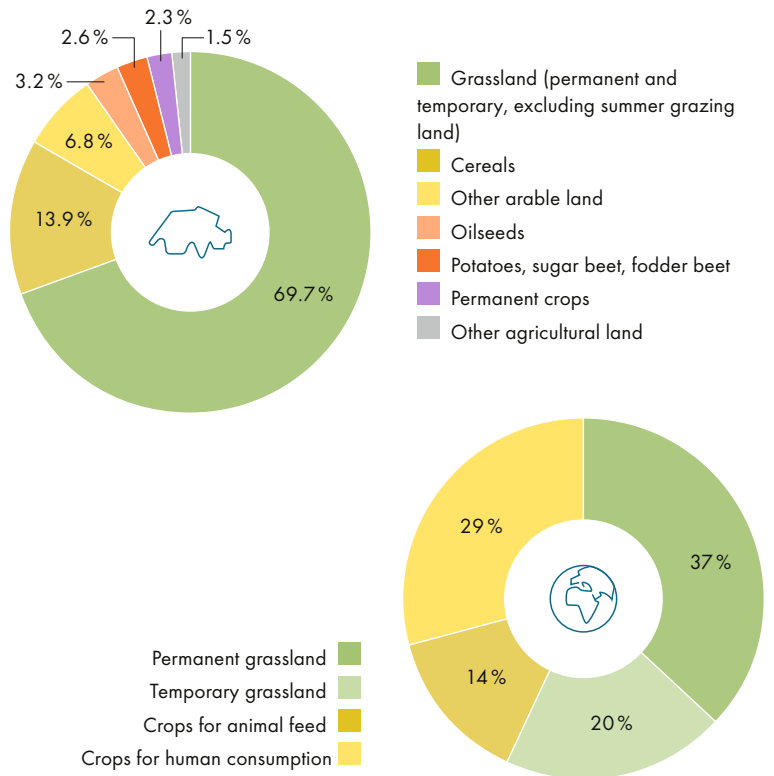
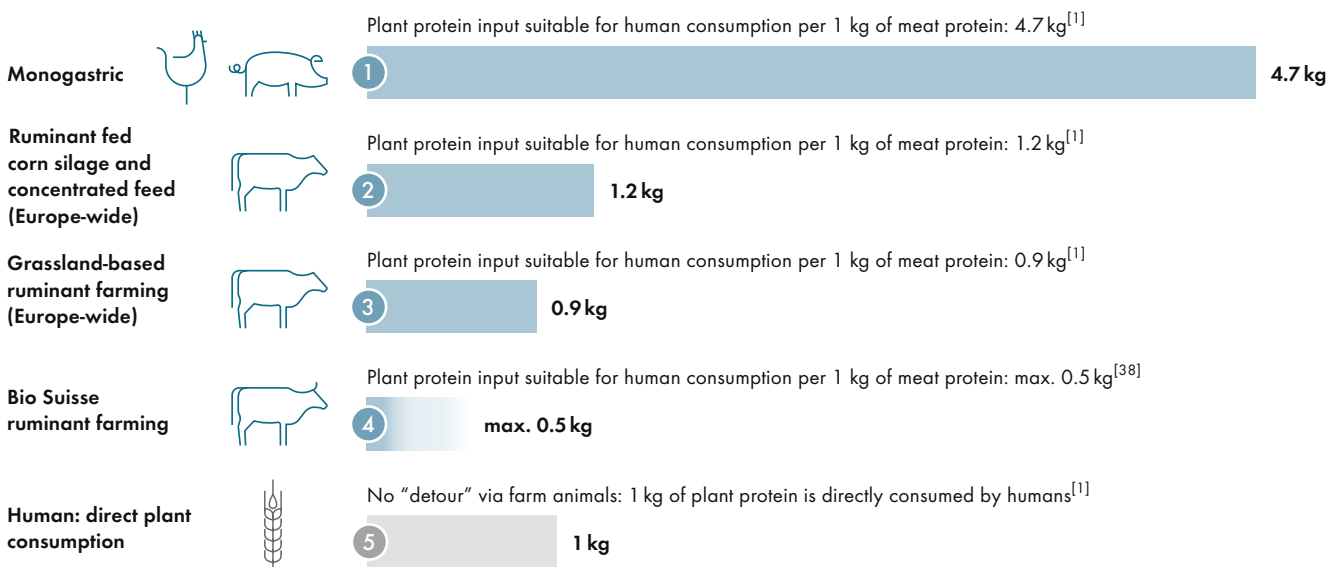


Figure 2: Plant protein required from arable land to produce 1 kg of animal protein^[1,29]



Ruminants convert plant protein that is indigestible for humans into high-quality animal protein on grassland (3, 4) and are very efficient in doing so. They need less than 1 kg of plant protein suitable for human consumption (5) to produce 1 kg of milk and meat protein. This means they require up to 8 times less plant protein compared to monogastric animals such as pigs and poultry (1). Average values for bars 1, 2, 3, 5 based on Mottet et al. 2017^[1]; 4 based on Bio Suisse feeding guidelines 2025^[29]

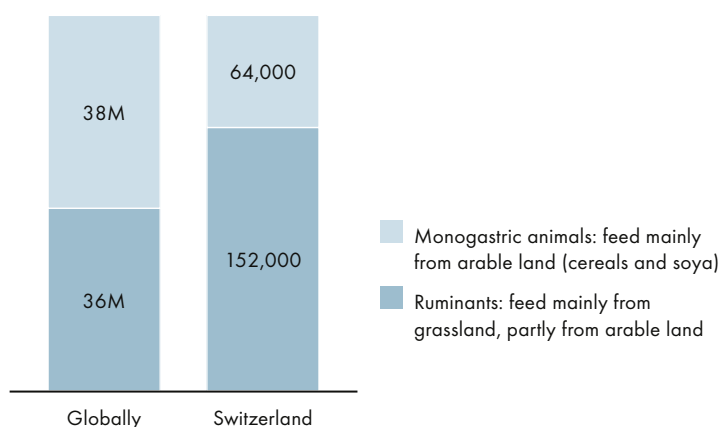
Contribution to food security

Worldwide, ruminants and monogastric animals such as pigs and poultry produce roughly the same amount of edible protein, namely 37 million tonnes per year each.^[1] In Switzerland, the ratio is different: ruminants provide more than twice as much food protein (152,000 tonnes) as monogastric animals (64,000 tonnes).^[2] Notably, most of this protein does not come from concentrated feed such as grain or soya, which are grown on arable land. Instead, it is mainly produced from grass, a resource that humans cannot directly utilise themselves; see Figure 3. Without ruminants, this plant protein would not contribute to human nutrition.

However, this statement does not apply equally to all production systems. In 2023, 72,962 hectares of grassland were farmed in Switzerland, approximately 78 % (564,768 ha) of which were used for “grassland-based milk and meat production” (abbreviated as “GMF” from German: Graslandbasierte Milch- und Fleischproduktion)^[2]. This means that a large proportion of Swiss meadows and pastures are farmed with roughage-consuming animals that feed mainly on grassland

Figure 3: Comparison of protein sources^[2]

Annual protein production in tonnes



Ruminants provide the majority of animal protein in Switzerland. Globally, only half of the animal protein for human consumption comes from ruminants. Figure adapted from [1][2].

Grassland protects the climate, soil and biodiversity

Storing carbon instead of releasing it

The sustainable use of grasslands not only secures the food supply but also makes an important contribution to climate mitigation. Natural meadows and pastures store large amounts of carbon, which has accumulated over decades in the dense root network of grasses and herbs within the soil.^{[3][4]} If this vegetation remains intact, the soil is protected from erosion, and CO₂ storage remains stable. However, if permanent grassland is ploughed up to make way for arable land or housing, the stored carbon is released back into the atmosphere.

Habitat for diversity

Extensively used meadows and pastures are among the most species-rich habitats in Europe. They provide a habitat for specialised insects, birds, small mammals and a diverse soil fauna. Grazing thus makes a decisive contribution to preserving the ecological value of these areas.

Cultural landscape with a future

Meadows and pastures are not only ecologically important, but they also shape the landscape and are part of Switzerland’s cultural identity. Their management preserves the basis of production for future generations^[5] and thus also secures food supplies in the long term.

Political recognition

The social importance of grassland is also reflected in agricultural policy: the direct payment programme “Grassland-based milk and meat production (GMF)” rewards pasture-based animal husbandry. The organic association Bio Suisse also emphasises the careful use of grassland in its guidelines, particularly by limiting concentrated feed and promoting roughage-based feeding.

Permanent grassland provides numerous ecosystem services

Grasslands protect the climate and nature: they store carbon, preserve biodiversity, and provide important ecosystem services for society.

Why are cows criticised for their impact on the climate?

The particular advantage of ruminants is their ability to efficiently utilise grass. However, this biological process inevitably produces methane: Microorganisms in the rumen break down the fibres in the roughage. This fermentation process only works in the absence of oxygen. During this process, released carbon atoms (C) combine with hydrogen (H) to form methane (CH₄).

Why methane is particularly significant in Switzerland

A cow emits around 130 kg of methane per year.^[6] Extrapolated to entire herds, such as those in Switzerland, this results in climate-relevant quantities. In countries with large livestock populations but little heavy industry or fossil-fuel energy production, agricultural methane emissions have a greater impact: they account for a larger share of total emissions. This is precisely the case in Switzerland, where methane from cattle farming plays a greater role in the climate inventory than in Germany, for example. This also increases the pressure on agriculture to reduce its emissions.^{[7][8]}

Considering methane in context

Methane is produced during ruminant digestion. In Switzerland, this proportion is particularly significant because there are no other major sources of emissions, such as heavy industry or the extraction of fossil fuels.

However, the contribution of ruminants to climate change must be seen in the broader context: cows use grasslands, a resource that does not compete with human nutrition while also providing valuable food.



Cattle consume grass that is inedible to humans. This produces methane. In Switzerland, these emissions are particularly significant because there are no other major emission sources. Nevertheless, cattle make an important contribution to sustainable nutrition.

How can greenhouse gases be compared?

Human-made climate change is one of the greatest challenges of our time. It is driven by various greenhouse gases, including carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). These gases amplify the greenhouse effect, causing Earth's surface to warm. However, their impact on the climate varies considerably, both in terms of intensity and how long they remain in the atmosphere.

CO₂ equivalents

To compare the climate impact of different greenhouse gases, results are expressed in CO₂ equivalents (CO₂eq). Each gas is compared to the reference value carbon dioxide (CO₂).

Calculation of climate impact

The basis for this is the global warming potential (GWP). It takes two key factors into account:

- How much a gas contributes to global warming (radiative effect)
- How long it remains in the atmosphere

The combination of these two factors determines the climate damage potential of a gas over a defined period of time.

Calculation periods for GWP

- **GWP 100:** effect over 100 years (standard in international climate inventories)
- **GWP 20:** effect over 20 years (particularly relevant for short-lived gases such as methane)

Climate impact of methane and nitrous oxide

Methane is a relatively short-lived gas that has a high climate impact at the outset. In the short term (20 years), it is around 80 times more potent than CO₂. However, within 20 years, most of the methane released into the atmosphere is converted into CO₂. The initially high climate impact thus decreases significantly. In the long term, its impact is approximately 28 times that of CO₂.

Nitrous oxide remains in the atmosphere for a very long time and has a climate impact that is 270 times stronger than carbon dioxide, regardless of the time period considered; see Table 1.

What is GWP*?

GWP* (pronounced "GWP star") is an alternative approach that not only quantifies the climate impact of a single gas molecule but also accounts for its change over time, particularly for short-lived gases such as methane. GWP* thus reflects the dynamic course of the impact.

GWP* does not replace GWP 100 or GWP 20

GWP* complements GWP 100 and GWP 20 by adding a dynamic perspective. Each of these methods answers a different question.

- **GWP 100:** How much does a gas contribute to global warming in the long term?
- **GWP 20:** How much does a gas contribute to global warming in the short term?
- **GWP*:** How much does a gas contribute to global warming over time? When is the effect of a relatively short-lived gas at its highest, and when does it weaken?

Table 1: Sample calculation for Global Warming Potential, GWP^[39]

Treibhausgas	CO ₂ eq according to GWP 20	CO ₂ eq according to GWP 100
1 kg methane	81.2 kg	27.9 kg
1 kg nitrous oxide	270 kg	270 kg

Methane is a relatively short-lived gas. Over a short period (20 years, GWP 20), it contributes approximately 80 times as much to global warming as CO₂. In the long term (100 years, GWP 100), methane still has around 28 times the effect of CO₂. Nitrous oxide remains in the atmosphere for a very long time and, calculated using GWP 20 and GWP 100, has a 270 times greater climate impact than CO₂.

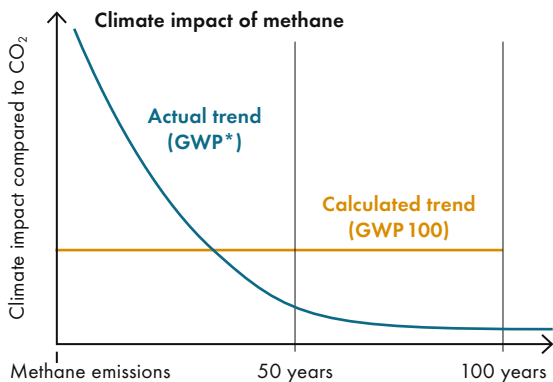
The Cooling-Effect:

What GWP* shows and what it does not

Unlike GWP 20 and GWP 100, GWP* assesses the effect of emissions relative to prior emissions from the same source; see Figure 4. This contextual approach is well suited to certain questions: GWP* can be used to show that a permanent reduction in methane emissions can lead to a temporary reduction in warming (cooling effect) because methane concentration in the atmosphere decreases. However, this effect is limited and ends once methane emissions stop declining and return to a stable level. After that, the climate continues to warm as long as CO₂ emissions do not also fall.

GWP* is unsuitable for calculating product-related climate footprints and yields implausible results. An example: a dairy farm has reduced its herd size from 100 to 50 cows over the last ten years. If we calculate the climate footprint per kg of milk using GWP*, the result is a negative value, indicating that higher milk consumption would reduce emissions. However, this does not correspond to reality.

Figure 4: Comparison of GWP* and GWP 100^[40]



The actual methane curve (blue line) shows a strong climate impact shortly after emission, which decreases significantly over time because methane is a short-lived greenhouse gas. The calculation according to GWP 100 (orange line), by contrast, shows methane as having a constant long-term effect. This does not capture the actual dynamics: the high initial impact remains underestimated, while the long-term impact is overestimated. GWP* more realistically depicts this temporal progression and is particularly suitable for illustrating reductions in methane emissions and their short-term impact on global warming. Figure adapted from [31].



Despite methane emissions, grassland-based cattle farming makes a valuable contribution to sustainable agriculture: it preserves species-rich pastures, opens up grassland for human consumption and conserves cultural landscapes.

Cattle farming is part of the solution

Even though ruminants emit methane, there are good reasons to maintain cattle farming on pastures and meadows. This is because ruminants perform key functions in the food system and ecosystems that cannot simply be replaced.

- They utilise grassland that would otherwise remain unused for human consumption.
- They provide high-quality protein without competing with the cultivation of plant-based foods.
- They promote biodiversity and carbon storage, especially in extensive grazing systems.
- They maintain cultural landscapes that are ecologically and socially valuable.

Cattle farming produces more than methane – it is part of the solution, not just part of the problem.

Reducing cattle farming would lower some emissions, but, at the same time, deprive the food system of important ecological and supply-securing services. Grassland areas would remain unused, valuable protein from land unsuitable for cultivation would be lost, and habitats for many species would disappear. This would jeopardise food security, sustainable land use and biodiversity.

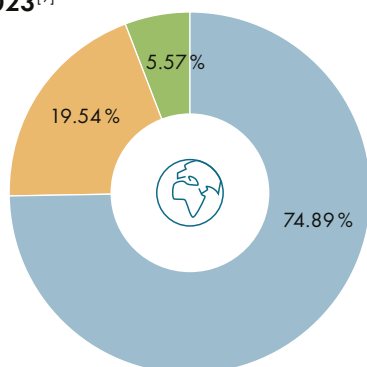
Greenhouse gases worldwide

Global warming is caused by several greenhouse gases. Based on GWP 100, carbon dioxide (CO₂) accounts for the largest share with around 75 % of global emissions, followed by methane (CH₄) with 19.5 % and nitrous oxide (N₂O) with 5.6 %; see Figure 5^[9]

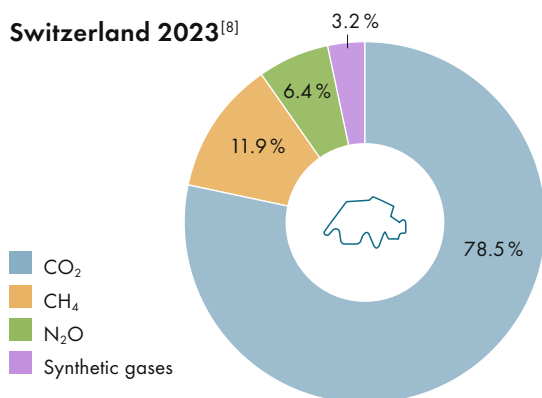
Calculated using GWP 20, the proportion of methane would be higher because its impact over 20 years is greater than over 100 years.

Figure 5: Global and Swiss greenhouse gas contributions (GWP 100)

Worldwide 2023^[9]



Switzerland 2023^[8]



Both globally and in Switzerland, carbon dioxide (CO₂) accounts for the largest share of greenhouse gas emissions, followed by methane (CH₄) and nitrous oxide (N₂O). Figure adapted from [8][9].

How greenhouse gases are produced

Carbon dioxide (CO₂)

CO₂ is mainly produced by the combustion of fossil fuels such as coal, oil and natural gas. It is the main gas responsible for global warming. In agriculture, CO₂ emissions are produced by:

- **Machinery and transport:** diesel, petrol
- **Fertiliser production:** energy use in industry
- **Liming and urea application:** not relevant in Switzerland
- **Drainage of peatland:** e.g. for arable or grassland use

CO₂ emissions from the respiration of animals and humans are not included in the greenhouse gas budget. This is because the carbon released in this process is absorbed from the atmosphere through photosynthesis. Plants fix carbon through photosynthesis and pass it on indirectly to animals and humans through feed. Through their respiration, it returns to the natural cycle; see Figure 7. Conversely, carbon sequestration through plant growth, such as grass growth, is not considered a sink in the agricultural climate balance.

Nitrous oxide (N₂O)

Nitrous oxide is produced in agriculture primarily through the storage and application of farmyard manure and the use of nitrogen fertilisers. It is produced both directly and indirectly:

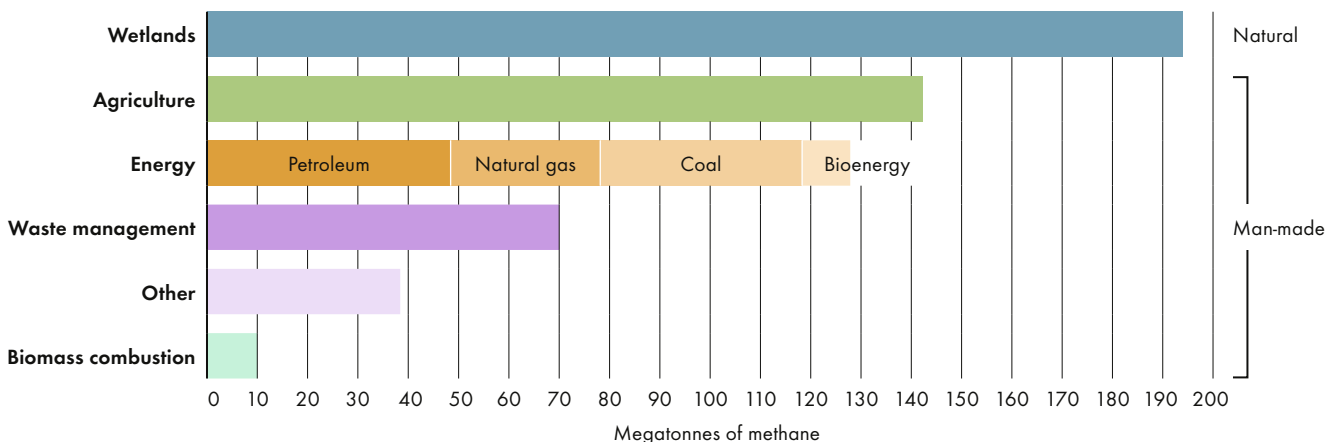
- **Directly:** through microbiological processes in farmyard manure during storage and in the soil after nitrogen input through fertilisation with slurry, manure or mineral fertilisers
- **Indirectly:** when nitrogen compounds such as ammonia, nitrate or nitrogen oxides are released into the environment (e.g. through leaching or the release of gaseous ammonia).

Methane (CH₄)

Methane enters the atmosphere from various sources. The most important are:

- **Wetlands:** natural microbial processes
- **Agriculture:** mainly from the digestion of ruminants (rumen fermentation), farm manure management and storage, and wet rice cultivation
- **Fossil fuel use:** during the extraction and transport of oil, gas and coal
- **Waste management:** landfills, sewage, incomplete combustion.

Figure 6: Methane sources (GWP 100) worldwide in 2023 by sector and origin^[41]



Methane enters the atmosphere from both natural (wetlands) and human-caused (anthropogenic) sources. The largest single source is natural wetlands, followed by agriculture, which is the most significant anthropogenic contributor. Other major emitters are the energy sector (broken down into oil, natural gas, coal and bioenergy) and waste management. “Other” and “biomass combustion” contribute to a lesser extent. Figure adapted from [32].

Biogenic and fossil methane

Regardless of its origin, methane has a harmful effect on the climate as soon as it enters the atmosphere. It does not matter whether it comes from a cow or a gas leak. However, the origins of the carbon in methane differ.

Table 2: Origins of carbon in methane and its emissions

Biogenic methane, e.g. cows	Fossil methane, e.g. natural gas
Carbon comes from current vegetation (fodder production, photosynthesis)	Carbon comes from fossil deposits (millions of years old)
Part of a closed carbon cycle	Addition of extra carbon to the atmosphere
Methane is released into the air through the digestive processes of ruminants	Released during the extraction of oil, coal and natural gas

Fossil methane releases additional carbon into the atmosphere.

Biogenic carbon dioxide and biogenic methane

Biogenic CO₂: A closed cycle

Carbon dioxide (CO₂) produced by the respiration of animals and humans or by the decomposition of plants is considered biogenic, i.e. of plant origin. This CO₂ comes from carbon that plants have previously extracted from the atmosphere through photosynthesis. When it is released again later, the total amount of CO₂ in the atmosphere remains unchanged.

Biogenic CO₂ is climate-neutral as long as vegetation regrows and the carbon cycle remains in balance.

Biogenic methane: impacts climate despite its plant origin

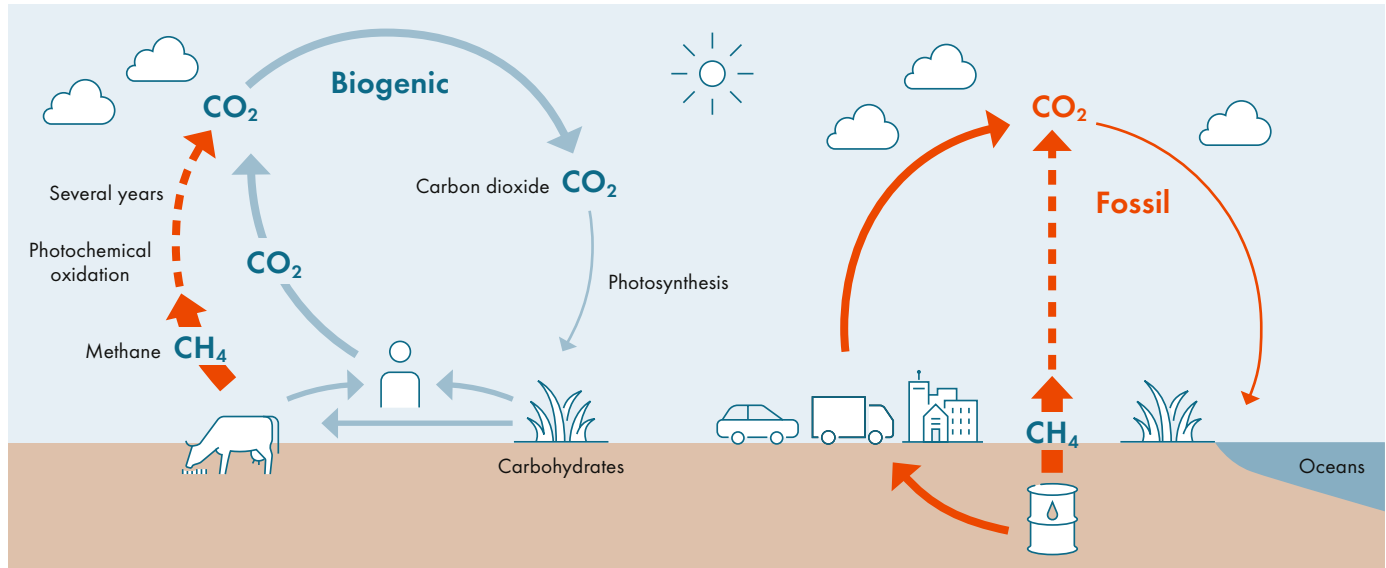
Methane (CH₄) from the digestion of ruminants is also biogenic in origin – the carbon it contains also comes from plants. But unlike CO₂, methane has a much stronger impact on the climate, especially in the short term.

Biogenic CH₄ is not climate-neutral, even though it is of plant origin, because it acts as an additional warming agent in the atmosphere.

Methane surplus increases global warming

Whether biogenic or fossil: if more methane enters the atmosphere than can be converted into CO₂ at the natural decomposition rate, global warming increases exponentially.

Figure 7: Biogenic and fossil carbon cycle



- Climate impact: More greenhouse gases are entering the atmosphere than can be broken down or absorbed by plants and oceans.
- If more methane enters the atmosphere over a period of 10 to 20 years than is converted into carbon dioxide (CO₂) during the same period, a methane surplus is created; see Figure 8.
- The natural (biogenic) carbon cycle involves the exchange of carbon dioxide (CO₂) between plants, animals and the atmosphere and includes processes such as photosynthesis and respiration. It has no impact on the climate..

Figure 8: Methane sources and sinks 2009–2019^[42]

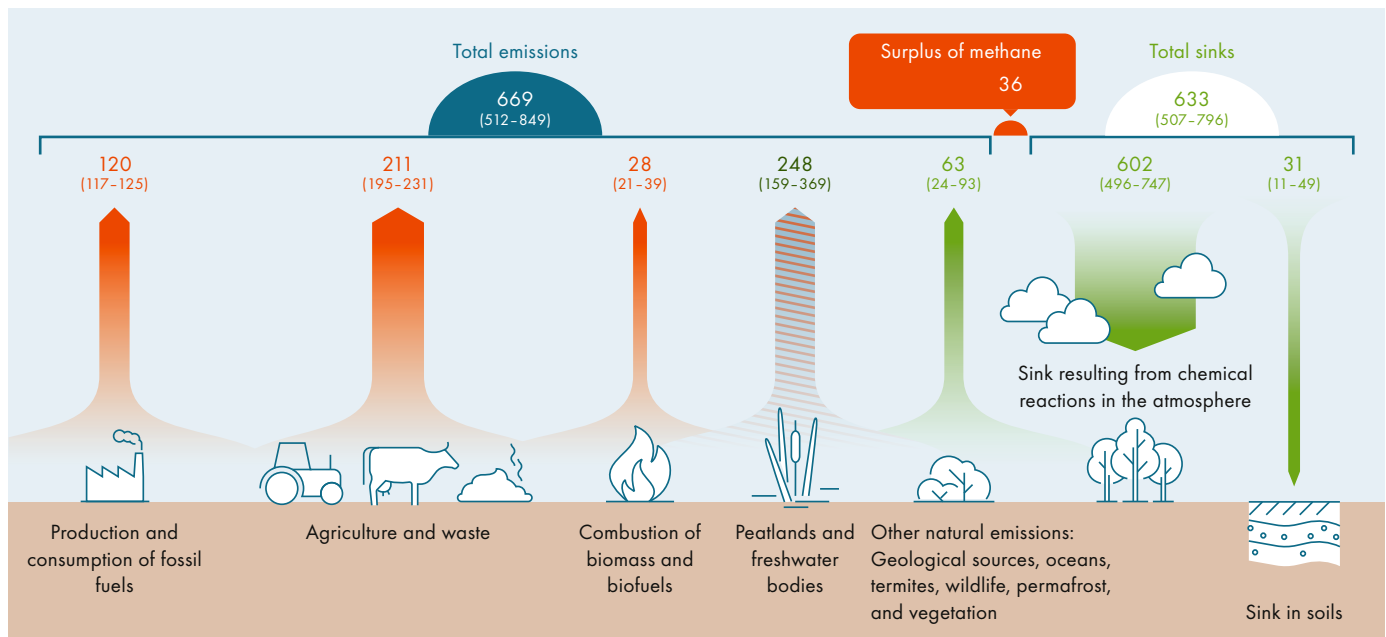


Figure adapted from [33]

Figures in teragrams (Tg) per year; 1 teragram = 1 million tonnes; the average values refer to the period 2009–2019, the values in brackets are the lowest and highest estimates given. There are two approaches to calculating methane sources and sinks: top-down (calculated from the air) and bottom-up (estimated from the ground). Only the bottom-up calculations are shown in this figure.

Greenhouse gases in Switzerland

Climate target for 2030

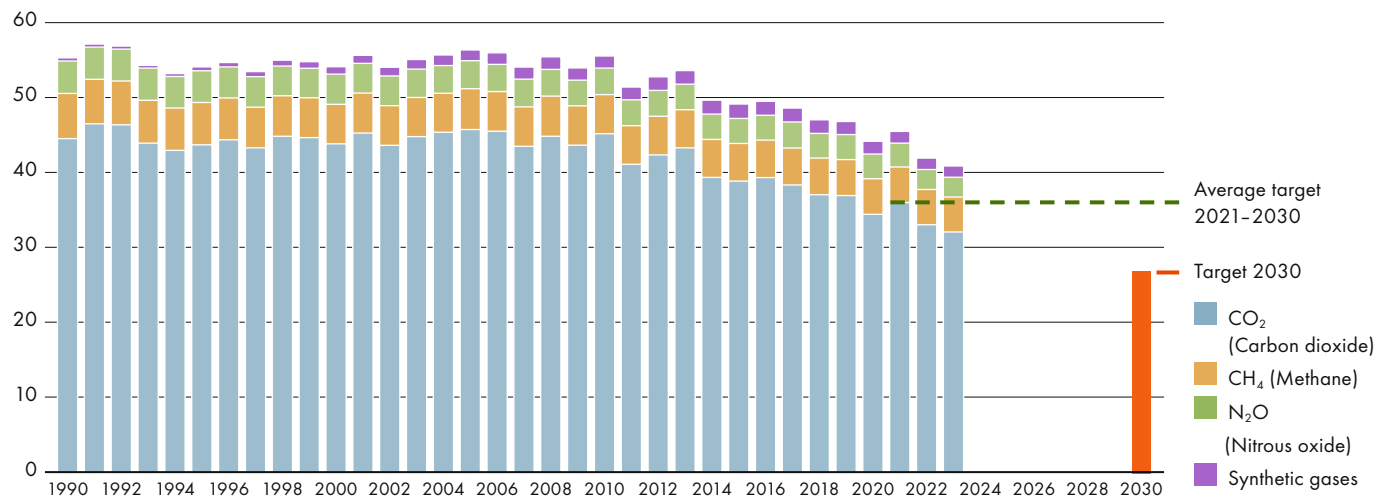
Under the Paris Climate Agreement, Switzerland has committed to reducing its greenhouse gas emissions by 50 % by 2030 compared to 1990 levels. Significant additional measures are needed to achieve this target.

Emission distribution by gas

The distribution of greenhouse gases in Switzerland roughly corresponds to the global pattern.

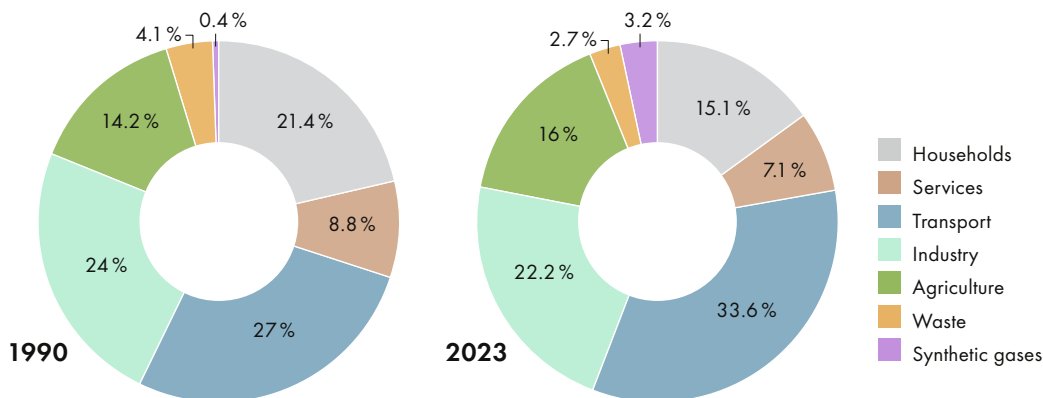
Figure 9: Development of greenhouse gas emissions (GWP 100)^[8]

Total greenhouse gas emissions
(Million tonnes CO₂ eq)



Switzerland's total greenhouse gas emissions are declining, but they remain well above the target reduction path of -50% by 2030 compared to 1990. The red line indicates the 2030 climate target. The green line shows a supplementary target: on average, emissions between 2021 and 2030 should be at least 35% below 1990 levels. Figure adapted from [8].

Figure 10: Emissions (GWP 100) by sectors in 1990 compared to 2023^[8]



The Swiss greenhouse gas inventory shows how emissions have changed by sector since 1990: the shares for transport, agriculture, and synthetic gases (e.g., for cooling) have increased, whereas the shares for the remaining sectors have decreased. Figure adapted from [8].

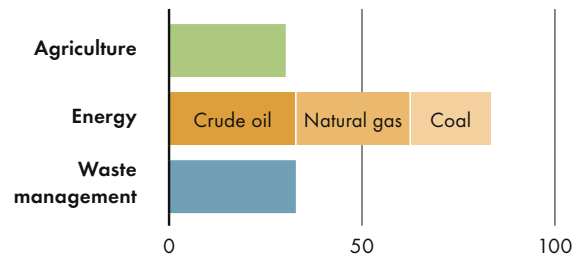
Reducing methane – especially in the energy sector

Methane is internationally recognised as a key lever for short-term climate mitigation. From a global perspective, the greatest potential for reduction lies not in agriculture but in the energy sector. According to the International Energy Agency (IEA), more than 80 megatonnes of methane could be saved worldwide by 2030 through:

- Sealing pipeline leaks
- Modernising infrastructure
- More efficient technical processes

In agriculture, the estimated global methane savings potential is approximately 30 megatonnes per year.

Figure 11: Methane savings potential^[43]



In the energy sector and in waste management, significant methane savings could be achieved without compromising food security. Figure adapted from [34].



To reduce excess methane in the atmosphere, emissions in the energy sector must be reduced through modernised infrastructure and more efficient technical processes. Completely abandoning cattle farming would also reduce emissions, but this strategy would deprive the food system of important ecological and supply-securing services. Climate mitigation alone is not enough to ensure a sustainable agricultural and food system.

How do grassland-based and intensive livestock farming differ in their climate impact?

Efficiency of livestock farming systems

A common argument in favour of intensive livestock farming is that it is more “efficient”. This claim is usually based on calculations of a product’s eco-efficiency. This involves determining the amount of greenhouse gases emitted per kilogram of milk or meat, for example. Since animals in extensive grassland farming often produce less milk and grow more slowly, they emit more emissions per kilogram of product than animals in intensive indoor farming. Species-appropriate feeding with roughage also increases methane emissions.

However, the one-sided focus on efficiency obscures key aspects of sustainability. Overly intensive agriculture can lead to a loss of soil fertility and make long-term use of the land impossible. Such consequences remain invisible in product-related assessments. The system boundaries of a calculation also play a role: for example, does it only consider local resource consumption or also the cultivation and import of feed from abroad? Different calculation methods and system boundaries, as well as a one-sided efficiency assessment, therefore, often lead to distorted results.

Differing assessment approaches for climate balance make comparison difficult

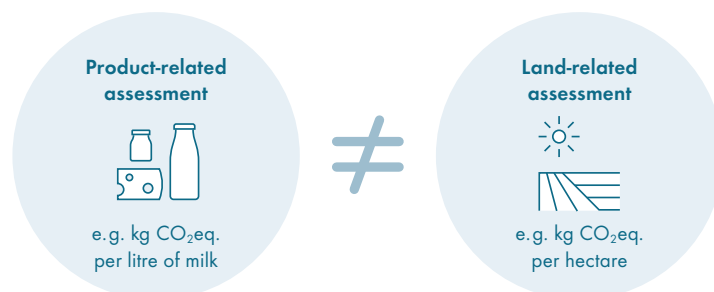
Although efforts are underway at the international level to make environmental* and climate balances comparable, this has only been achieved to a limited extent so far. Organic farming is particularly disadvantaged here, as its complex systems, such as the concept of closed cycles, are poorly represented in current models.

*Environmental balance = life cycle assessment (LCA) = Systematic method for assessing the environmental impact of a product, service or process throughout its entire life cycle, from raw material extraction to disposal.

Climate balance alone is not enough

Product-related calculations capture efficiency, but not total emissions, which are ultimately decisive. If the climate footprint is used as the sole indicator, many important aspects for a comprehensive sustainability assessment are missing.

Figure 12: Methods for climate balance assessment



Climate balances calculated using different methods are not directly comparable. Product-related emissions provide insights into a product’s efficiency, but they are highly dependent on the factors taken into account. Land-related emissions must be broken down by land category (e.g. permanent grassland vs. cropland) to allow for meaningful conclusions.

Example 1: Gladbacherhof study vs. Swiss organic farms

One example is the Gladbacherhof study from Germany.^[10] It concludes that grassland-based milk production results in higher emissions, but only as a product-related climate balance based on milk yields. The underlying yield was assumed rather than measured and was significantly lower than the actual yield measured over six years on more than 40 grassland-based Swiss organic farms.^[11] Based on Swiss data, many farms have lower carbon footprints per kg of milk than reported in the Gladbacherhof study.

Organic farming needs holistic assessment models

Viewed holistically, location-adapted grassland- and pasture-based cattle farming can reduce climate impacts.



New meta-studies show that grazing can be less harmful to the climate than intensive indoor farming. Organic systems in particular perform slightly better in terms of climate impact, while also consuming less energy and causing less environmental damage through overfertilisation and soil acidification.

Example 2: Grazing is not harmful to the climate

A meta-analysis conducted at the University of Kiel^[12] evaluated more than 30 scientific papers from 15 countries and compared the climate impacts of milk production across various systems, from pasture-based to intensive indoor housing. The result: grassland-based milk production can cause fewer greenhouse gas emissions per kg of milk than intensive indoor housing. The prerequisites are a location with very good conditions for grazing and cows that make optimal use of roughage and convert it into good milk yields.^[13]

Example 3: Review study compares climate impacts

Another recent review published in a Nature publication^[14] evaluated scientific publications worldwide that compare the climate impacts of conventionally and organically produced food. It shows that beef and milk from organic production have a lower global warming potential per area and the same potential per product unit. This finding is based on 22 studies for milk and seven studies for beef. The difference is not large, but the comparison is slightly in favour of organic ruminant products.

In terms of other environmental impacts, such as soil acidification, nutrient oversupply in ecosystems and energy consumption, organic milk also performs significantly better than conventionally produced milk in this review.

Comparative study shows organic products can be more climate-friendly

Organically produced milk and beef have a lower global warming potential per area and the same high potential per product unit as conventional products, and offer advantages in terms of energy consumption, eutrophication and soil acidification.

How can methane emissions from ruminants be reduced?

Two strategies and their limitations

Two approaches are often the focus of efforts to reduce methane emissions from cattle farming:

- **Reduction in livestock numbers**, particularly ruminants, due to their digestive methane production
- **Increase in productivity per animal** through more intensive farming to produce more food, in relation to methane emissions

However, both strategies conflict with grassland-based, sustainable animal husbandry, as practised, in particular, in organic farming.

1) Reduce livestock numbers where appropriate

In regions such as parts of Central Asia and Northern China, where grasslands are overgrazed for economic and political reasons, a reduction in livestock numbers may be necessary: excessive numbers of animals damage the turf and soil structure in these areas.^[15]

In Europe and also in Switzerland, the picture is different: there is an increasing shortage of animals to make sufficient use of and maintain permanent grassland in mountain regions.^[16] The decline in grazing is leading to the loss of valuable land resources that can no longer contribute to food production.^[5]

Fewer cows?

For Swiss grassland, only reasonable to a limited extent

Too few ruminants on natural meadows and pastures means that these land resources are lost for food production. A general reduction in livestock numbers is therefore not advisable for Swiss grassland.



Organic farming focuses on grassland-based feeding with robust, locally adapted animals, rather than increasing individual animal performance through concentrated feed.

2) Intensification – not a goal for organic farming

Higher individual animal yields through breeding and energy-rich feed reduce methane emissions per kilogram of milk, but have undesirable side effects:

- High milk yields require the use of energy- and protein-rich concentrated feed. This is grown on land in Switzerland and abroad that could also be used for the production of plant-based food for human consumption. This contradicts the principle of grassland-based production in organic systems.
- Rather than maximising production output, the focus is on cows that can efficiently utilise roughage. This breeding goal differs significantly from that of intensive milk and meat production.

Efficiency instead of maximum performance

Although intensification through high individual animal performance reduces methane emissions per litre of milk, it requires large quantities of concentrated feed from arable land domestic and abroad. This contradicts grassland-based organic animal husbandry. The focus is not on maximum performance, but on the efficient utilisation of roughage by robust animals adapted to their location.

Assessment of possible measures in organic farming

Breeding, extending the useful lifespans of animals, improving pasture management, adjusting feed, and enhancing farm manure storage and management are potential strategies for reducing methane emissions.

1) Start with breeding

Appropriate performance can also be achieved on grassland with suitable cows. Some breeds can produce considerable quantities of milk from high-quality meadow and pasture feed, while being less harmful to the climate than concentrate-intensive systems.^[12]

Robust animals and dual-purpose breeds

In less productive mountainous areas, more robust animals or dual-purpose breeds are in demand. These can cope with the grassland at this altitude, do not require concentrated feed and use the grassland efficiently.

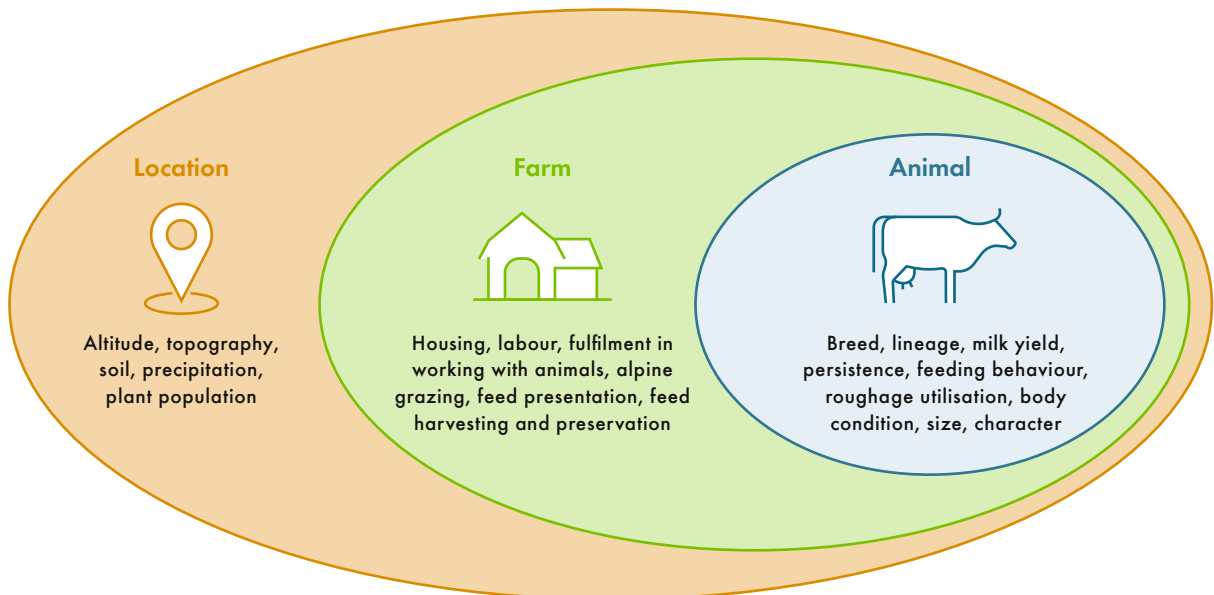
Dual-purpose breeds and crossbreeds also offer the advantage of producing both milk and meat and have a good carbon footprint.^[17] The key factor here is adapting the genotype and feed resources to the location. Not every breed is suitable for every farm, so it is hardly useful to make blanket recommendations based on individual studies.

FiBL assessment form for site-appropriate dairy cattle breeding

To help assess whether breeding is appropriate for the location and farm, a FiBL tool is available free of charge at:

shop.fibl.org > 1411 Assessment form for site-appropriate dairy cattle breeding (German)

Figure 13: Location, farm and animal in harmony



In organic farming, animals, the farm and the location should be in harmony. This seems simple at first glance but poses challenges in implementation. Even the best forage location will not do justice to a high-performance animal if the operational conditions are inadequate – this includes the available working time or the personal interests and living environment of the farmers and their employees. Similarly, a farm with the best personnel and technical resources cannot fully compensate for an unfavourable location in terms of climate. It is therefore important to analyse the location, farm, and herd in detail and to coordinate them with one another.



Species-rich forage, especially herbs with high levels of tannins and secondary plant compounds, has the potential to reduce methane emissions from ruminants..

2) Reducing methane through feeding

From a feeding perspective, three approaches to reducing methane emissions are commonly mentioned. However, these are often difficult to implement and, in some cases, not permitted in an organic context.

2.1) Plant-based substances and herbal additives

- Moderate proportions of up to 10 % in the food ration promote animal health, protein utilisation and food quality.^[5]
- Promoting herb-rich pastures and meadows is beneficial, even if the effect on methane emissions is difficult to measure.^[18]
- Herbs with high levels of bitter compounds and other bioactive compounds can inhibit methane production.
- Disadvantage: High doses with proven effects are difficult to implement in practice, largely because of the large area required to cultivate the herbs.^[19]

2.2) Synthetic methane inhibitors

Example: 3-NOP (Bovaer®)

- Long-term studies show a permanent 20 % reduction in methane emissions over one lactation^[20], but only in Holstein cows and much less in Brown Swiss cows (only 13 %)^[21]
- Targets methane-producing microorganisms (archaea) in the rumen without attacking other microorganisms.

- Influences the rumen ecosystem.
- Has no negative effects on animal health, the rumen environment (pH and short-chain fatty acids), milk yield, or milk constituents.^{[18][22]}
- Disadvantages:
 - Only works with continuous feeding^[23] – therefore, not currently suitable for grazing or pure hay feeding..
 - Is a synthetic substance and therefore not permitted in organic animal feed.

2.3) More intensive feeding with sugar-rich grasses, oilseeds or energy and protein concentrates

- More concentrate feed or oilseeds in the ration increases performance and reduces methane emissions per kilogram of feed intake, as the fibre content in the ration decreases.^[24]
- Disadvantages:
 - Contradicts the principles of grassland use and increases competition for food.
 - Is not feasible given the 5 % concentrate limit for organic farming.
- It makes sense to use the 5 % concentrate feed permitted by Bio Suisse to balance out any nutrient deficiencies in pasture feed. This improves the utilisation of pasture grass, which contributes to sustainability

3) Extending lifespans

The productive lifespan of a dairy cow – i.e. how long it produces milk – is a decisive factor in its carbon footprint.

Longer productive lifespan – better carbon footprint

The longer the animal lives and remains productive, the better distributed are its metabolic turnover and, with it, the methane emissions from rearing and husbandry per kilogram of milk produced. With each lactation, the daily lifetime yield increases, as the “non-productive” rearing months become relatively less significant (see Figure 15).

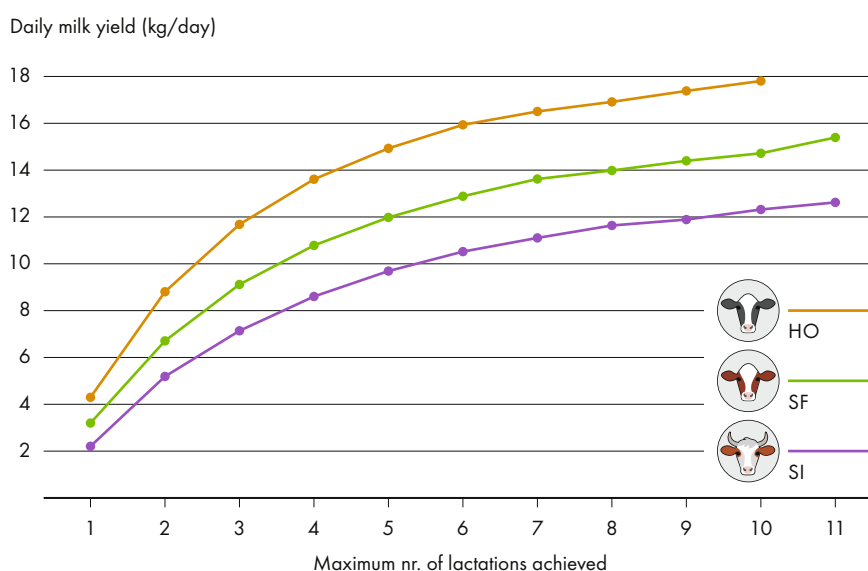
In many Swiss breeds, milk yield increases significantly until at least the fifth lactation and then remains at a high level for several years. Nevertheless, many cows are slaughtered before this point, which not only worsens the climate balance but can also be economically disadvantageous. Currently, dairy cows in Switzerland are slaughtered after an average of 3.0 to 3.8 lactations, i.e. before they have reached their full production potential.

Sustainable effects of longer utilisation in dairy cows

- Less need for replacement > fewer animals needed for rearing > better carbon footprint per kg of milk
- More crossbreeding possible > more calves available for fattening > meat production possible directly from dairy farming via grassland-based fattening systems > fewer suckler cows needed for a consistent meat supply > better carbon footprint per kg of milk and meat (see Figure 16)^[25]
- Longer productive lifespan for dual-purpose breeds > better carbon footprint through coupled milk and meat production^{[25][26][27]}

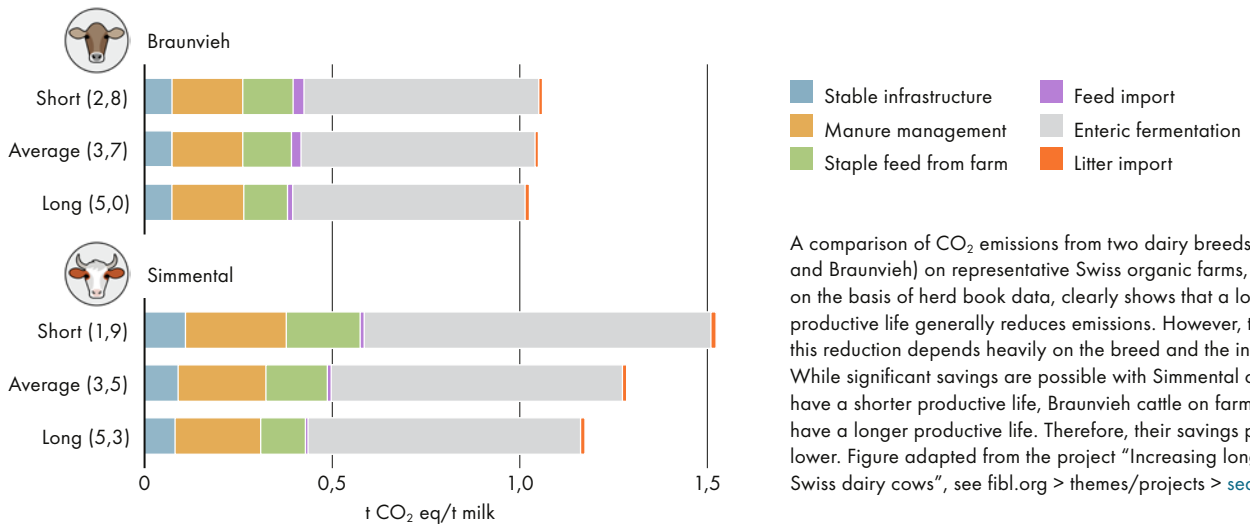
Good health and fertility are crucial for a long, productive life. Among other factors, these depend on whether the farm meets the cow’s needs given its genetic performance potential. The higher the performance, the higher the requirements for husbandry and feeding.

Figure 14: Milk yields and productive life



Daily milk yield (kg milk per day of life) increases steadily with longer productive life. The three breeds, Holstein (HO), Swiss Fleckvieh (SF), and Simmental (SI), exemplify a spectrum from demanding (HO) to adaptable (SI). A longer productive life is advantageous in all cases. Figure adapted from the project “Increasing longevity of Swiss dairy cows”, which was supported by the FOAG and numerous industry and other organisations see fiBL.org > themes/projects > search: 50114.

Figure 15: Comparison of carbon footprints in tonnes of CO₂eq per tonne of milk from Braunvieh and Simmental cattle with short, average and long productive lives (years)



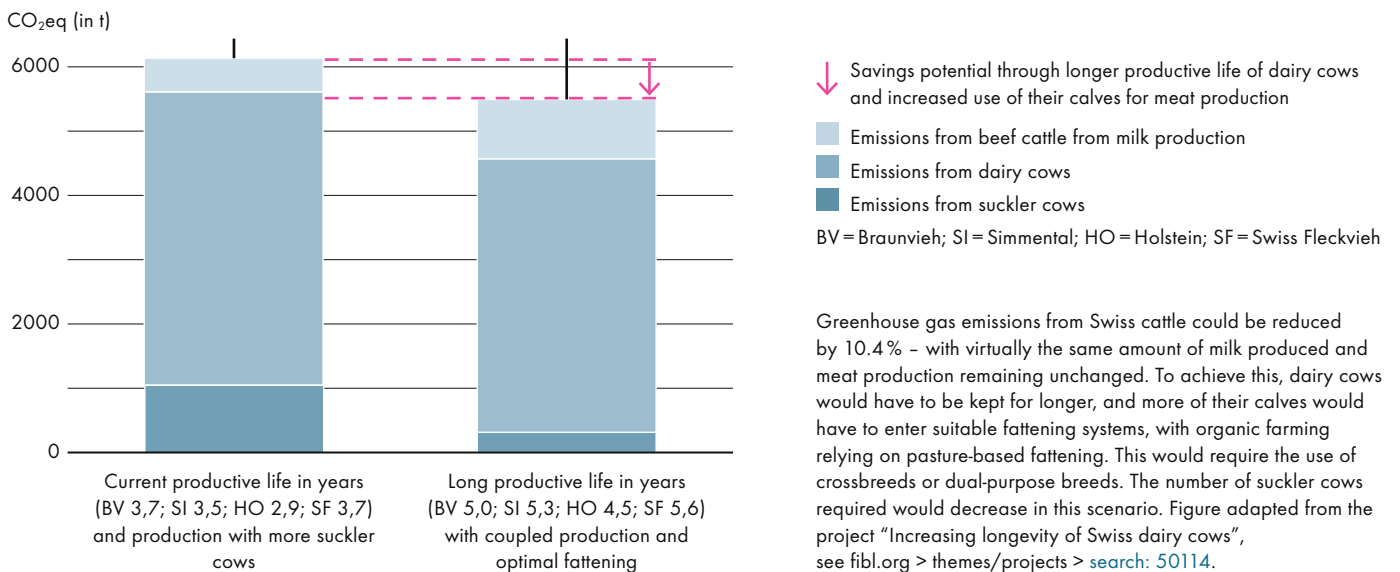
A comparison of CO₂ emissions from two dairy breeds (Simmental and Braunvieh) on representative Swiss organic farms, modelled on the basis of herd book data, clearly shows that a longer productive life generally reduces emissions. However, the extent of this reduction depends heavily on the breed and the initial level. While significant savings are possible with Simmental cattle, which have a shorter productive life, Braunvieh cattle on farms already have a longer productive life. Therefore, their savings potential is lower. Figure adapted from the project "Increasing longevity of Swiss dairy cows", see [fiBL.org > themes/projects > search: 50114](http://fiBL.org/themes/projects/search:50114).

Climate-friendly meat production from dairy farming

A transition to longer productive lives for dairy cows can not only improve the carbon footprint but also contribute to the meat supply. If rearing management is optimised and greater emphasis is placed on crossbreeding, more dairy calves can be used for fattening without maintaining additional suckler cows. This keeps meat production stable while reducing greenhouse gas emissions from the entire cattle population by over 10 % (see Figure 16).

Combining milk and meat
 If meat is increasingly obtained from dairy farming, for example, through dual-purpose crossbreeding and dual-purpose breeds, there is no need for additional suckler cows. This secures the meat supply and reduces emissions from cattle farming.

Figure 16: Lower emissions for the same amount of meat due to longer productive life



4) Optimising pasture management

Permanent grassland stores carbon – provided it is carefully managed. Humus builds up over many years and only reaches a stable level if the area is not overused. If grazing is too intensive, plant mass and root content decrease and the humus content declines.

Modern grazing systems

Portion grazing or mob grazing promotes short, targeted grazing phases with long rest periods. Especially in tropical regions, such systems have been shown to stimulate root growth, increase underground biomass and promote carbon accumulation in the soil.^[27]

Good grazing management helps preserve humus

Permanent grassland can store carbon over the long term, thereby serving as a climate mitigation area.

5) Improve farmyard manure storage and management

Farmyard manure includes all organic fertiliser materials that are produced directly on the farm and reused:

- Solid: manure, manure compost, digestate
- Liquid: slurry, liquid manure, fermented slurry

Manure is produced in livestock housing and consists of straw, litter, and solid organic material. Slurry and liquid manure are liquid organic fertilisers consisting of varying proportions of animal urine and faeces. Slurry has a greater fertilising effect than liquid manure due to its higher dry matter/faeces content.

Composting describes the aerobic conversion of organic matter. This releases nutrients and CO₂ and converts the organic matter into more stable forms. In manure composting, farmyard manure is broken down aerobically (with oxygen) through aeration and mixing in a controlled environment. This process:

- significantly reduces methane emissions,^[28]
- improves stability, fertiliser quality and hygiene,^{[28][29]} and
- stabilises the soil structure.^[28]

Sources of emissions from farmyard manure

Farmyard manure is a source of the greenhouse gases methane (CH₄), nitrous oxide (N₂O), ammonia (NH₃) and other nitrogen oxides. The latter are released into the environment, where they lead to indirect nitrous oxide emissions and contribute to biodiversity loss through eutrophication (nutrient oversupply). A significant proportion of ammonia emissions do not originate in pastures, but rather:

- in livestock housing,
- during the storage of farm manure, or
- during the spreading of slurry and manure.

Farmyard manure-based recycled fertilisers, such as fermented slurry or digestate, only lead to a limited reduction in emissions.^[30] In general, key properties of farmyard manure, such as nutrient content and dry matter, vary greatly depending on the livestock housing system and type of processing. Since individual measures can also lead to shifts in emissions along the processing chain, it is important to consider the overall impact of livestock housing, storage, and spreading.

Table 3: Emission reduction

Measure	Effect
Composting manure	Reduces CH ₄ /NH ₃ through aerobic decomposition ^[31] and N ₂ O emissions from the soil ^[32]
Cover slurry and shorten storage time	Prevents emissions during storage ^[33]
Separation of urine and manure in the stable	Reduces ammonia formation in the stable ^[34]
Injection/close-to-ground application	Reduces ammonia emissions during application ^[34]
Rapid incorporation (within 1 hour)	Reduces emissions after application ^[34]
Biogas plants	Reduces CH ₄ emissions during storage ^[34] ; risk of higher NH ₃ emissions during storage ^[35] and application ^[36]
Optimal application	Cool weather, just before rain, no wind: reduces NH ₃ emissions ^[34] ; fertilisation according to requirements minimises N ₂ O emissions

CH₄ = methane; NH₃ = ammonia; N₂O = nitrous oxide

Why is climate mitigation alone not enough for sustainable agriculture?

Mitigating climate change is one of the most pressing issues of our time. It affects all areas of life, including agriculture. But it is not the only crisis we face: biodiversity is declining, pollinating insects are disappearing, soils are becoming impoverished, water bodies are being overfertilised, and agricultural land is being lost.

Climate mitigation alone is not enough

Those who focus solely on climate mitigation risk losing sight of other key sustainability goals. Only a holistic approach can protect the environment, food supplies and livelihoods in the long term.

This is best achieved through cycle-oriented agriculture, in which livestock farming is based on grassland.

Location is key

In pasture farming, animal numbers and feed bases are adapted to local conditions. This results in fewer nutrient surpluses, less environmental pollution, and the production of valuable protein from areas that would otherwise not be used. Using grassland resources reduces competition for land between plant-based food for humans and animal feed. Transport distances are shorter, cultural landscapes are preserved, and meadows remain habitats for insects, birds and soil organisms.

More than just a carbon footprint

Sustainable agriculture in the future requires more than a reduction in greenhouse gas emissions.

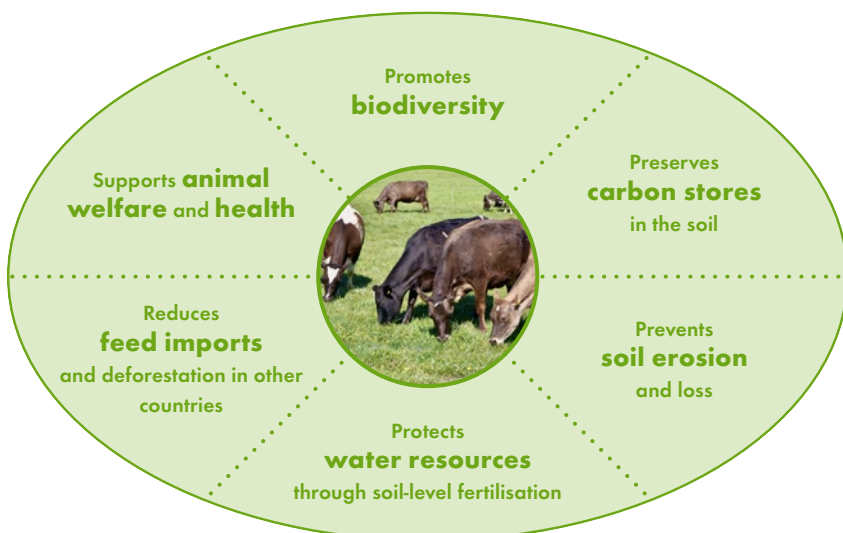
It must:

- Promote biodiversity to keep ecosystems stable.
- Preserve soils and meadows that store carbon.
- Protect water through soil-based animal husbandry.
- Secure balanced, local sources of protein that do not rely on imports with outsourced negative environmental impacts.

Sustainability requires a circular approach

Climate mitigation alone is not enough. Sustainable agriculture must also protect soil, water and biodiversity and secure regional protein sources. Grassland-based animal husbandry is a central component of this: it uses local resources efficiently, reduces environmental impacts, stores carbon, and integrates food security with ecosystem protection.

Figure 17: Benefits of grassland-based livestock farming



Grassland-based livestock farming combines the promotion of carbon sequestration in the soil with numerous other benefits.

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Further information

Publications

Assessment form and information sheet “Site-appropriate dairy cattle breeding”

shop.fibl.org > 1411 (German)

Factsheet “Soil and climate”

shop.fibl.org > 1349

Factsheet “Farmyard manure and recycled fertiliser in organic farming”

shop.fibl.org > 1800 (German)

Factsheet “Climate mitigation on organic farms”

shop.fibl.org > 1552 (German)

Bio Suisse factsheet on organic farming and climate mitigation

bioaktuell.ch > Nachhaltigkeit > Klima > Klimawandel und Biolandbau > Bio Suisse factsheet on organic farming and climate mitigation (German)

Book “Die Kuh ist kein Klimakiller”

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MeinHofKompass

The digital guide to ecological, social and economic Swiss organic farming!
app.meinhofkompass.ch (German)

FiBL Focus podcast (German)

Kuh und Klima

fibl.org > Infothek > Podcast > FiBL Focus > Folge Nr. 103

Die Landwirtschaft – Klimakiller oder Klimaretter?

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Der klimapositive Biolandbau – eine politische Mär?

fibl.org > Infothek > Podcast > FiBL Focus > Folge Nr. 37

FiBLFilm videos (German with English subtitles)

Comparing organic fertilisers: effects on climate, yield and soil biology

youtube.com > FiBLFilm > Organic fertiliser

High grass grazing or mob grazing: adapting pasture management to the consequences of climate change

youtube.com > FiBLFilm > High grass grazing or mob grazing



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