DAIRY COWS GRAZING TO THE FUTURE

While bucolic images of dairy farming persist in our collective imagination, cows are now rarely to be found grazing in pastures. Indeed, grazing systems are undergoing shifts that are simultaneously shaped by profitability and societal expectations related to the environment, animal welfare, and food nutritional quality. A key question thus arises: is a return to grass-based systems possible or desirable?

In 2021, milk production was in full swing across the entire globe. Although most current systems utilise cows, other mammalian livestock are represented as well. That said, milk production systems can vary dramatically, even within countries. From alpine pastures to mega-farms, what does dairy farming look like at present in the real world?

DAIRY FARMING CURRENT PRACTICES

Humans have been consuming animal milk since mammals were first domesticated nearly 10,000 years ago. Regardless of its source, animal milk is rich in proteins, vitamins, minerals, and essential fatty acids, making it a nutritionally complete food. Around the world, people of all ages include milk in their diets. *"According to the FAO, cow's milk (from all breeds combined) volumetrically accounted for 81% of global milk production in 2019. Since World War II, production levels have increased significantly, thanks to advances in livestock genetics and feed quality. In 2020, a total of 850 billion litres was generated",* comments Vincent Chatellier, an economics researcher in the Structures and Markets in Agriculture, Resources and Territories Joint Research Unit (SMART, INRAE Centre of Brittany-Normandy). Milk is the starting point for the essential and diverse dairy products consumed by human populations, including liquid and powdered milk, yoghurt, cheese, butter, cream, and dairy desserts.

Three main production systems

Dairy farming takes on extremely different forms, including among regions within the same country. There are three main production systems, which differ based on how the animals are nourished: pastoral systems, mixed systems, and industrial systems. While animals mostly consume forage (60-80%) in all three systems, the source of this forage varies greatly and is determined by country geography, climate, and crop type. Farmers often use concentrates, which are formulated from grains, legumes, and oilseeds. While concentrates are most commonly purchased, they may also be prepared using a farm's own crops.

438,000
dairy cattle farms in Europe

151.3 billion
L/year produced in Europe (out of 850 billion litres produced worldwide)

References:
Économie laitière 2020 – CNIEL, Réseau info comptable agricole en France et Europe (RICA) – 2018.

Pastoral systems: highly localised

According to the 2014 *Atlas de l'élevage herbivore*, pastoral systems are responsible for 9% of global milk production (in litres; FAO figures from 2010). In these systems, cows consume a diet that is 90% fresh grass and hay. Pastoral systems are common in areas that are poorly suited to crop farming, such as mountain plateaus and non-arable lands (e.g., steppes, savannas). Livestock herds are shifted among pastures across seasons, giving the grass time to grow back. Pastoral farming is still used in many parts of the world, including in Europe, the Americas, Australia, Africa, and East Asia. The degree of movement varies, from nomadism in Africa to large-scale private ranching in North America to transhumance in

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Europe. In France, pastoral farming is largely found in high-elevation regions.

Mixed systems: the norm

Mixed systems predominate across the globe as they represent 81% of all production systems. However, they exist in highly diverse forms. Mixed systems have grasslands for livestock grazing and fields for producing crops intended for consumption by humans or livestock (e.g., grains, oilseeds, legumes). Livestock manure is then used as crop fertiliser. Farmers may use concentrates to increase milk yields per animal, ensuring consistent production throughout the year. *"Mixed systems are, by far, the most common system type in Europe. However, there is variation in the relative consumption of different grass types (e.g., fresh grass, silage, baled silage). Such systems occur throughout France, on both plains and piedmont slopes"*, explains Jean-Louis Peyraud, special adviser at INRAE's Scientific Directorate for Agriculture and researcher in the domain of animal production.

Industrial systems are concentrated in China and the US

Industrial systems are responsible for less than 10% of global milk production (in litres). Livestock are largely fed using concentrates (90%), although some forage is provided as well. These systems are also sometimes described as using *"off-soil production" because they have become untethered from land-based, farming resources. Industrial dairy farming first emerged in the 1960s, as a response to increasing demand. On the global scale, examples include dairy feed lots in the US and China, which host tens of thousands of cows, and intensive dairy farms in Israel, which contain smaller numbers of animals that generate extremely high individual yields (15,000 litres/year). "In Europe"*, remarks Jean-Louis Peyraud, *"industrial systems remain rare. It is more cost effective to produce forage than to bring it in from off site, given transportation costs".*

↑ The first milking robots began to be used on farms in the early 21st century. Mobile versions are sometimes employed to milk animals that are grazing in mountain pastures.

Percent contribution of different systems to volumetric milk production

Pastoral: 9%

Mixt: 81%

Industrial: 10%

Source: *Atlas de l'élevage herbivore* (2014), drawing on FAO data (2010).

The role of Europe

Around the world, milk is produced via three main systems, whose degree of profitability is shaped →

Mixed production systems predominate across the globe.

by geographical, climatic, and political constraints and opportunities. "*Tremendous diversity can be found in the European Union (EU-27), which produces more milk than either the US or India. EU production levels reached 151.3 billion litres per year in 2018*", notes Vincent Chatellier. Almost all of the 438,000 cattle dairy farms found in Europe are family establishments that use mixed systems.

Jean-Louis Peyraud comments: *"Herd size differs among countries. Some major dairy producers, such as France, Ireland, and the Netherlands, have opted for medium-sized herds of around 60 to 80 cows. Others have gone for larger herds. For example, in Denmark, herds tend to exceed 150 to 200 cows. Germany has herds of over a thousand head."* Yields vary across countries, from 3,200 litres/cow in Romania to 9,500 litres/cow in Denmark.

While the surface area dedicated to farmland is stable or even growing in EU countries, levels of grazing are in decline. Farms are switching to conserved forage that is produced on site. ●

In Europe, grazing is in decline as farmers switch to conserved forage.

FOCUS

2021 snapshot of French dairy farms

BREED

HERD SIZE
Average: 60–80 head, Maximum: 200 head

GRAZING DURATION
Varies across regions from 0 to 290+ days

AVERAGE FARM SIZE
56 ha of grassland, including 19 ha of sown grassland

FORAGE AND GRASSLAND TYPES
Permanent in mountainous regions and on plains (> 5 years old), temporary on plains (1-5 years old)

AVERAGE AGE AT 1ST CALVING
36 MONTHS

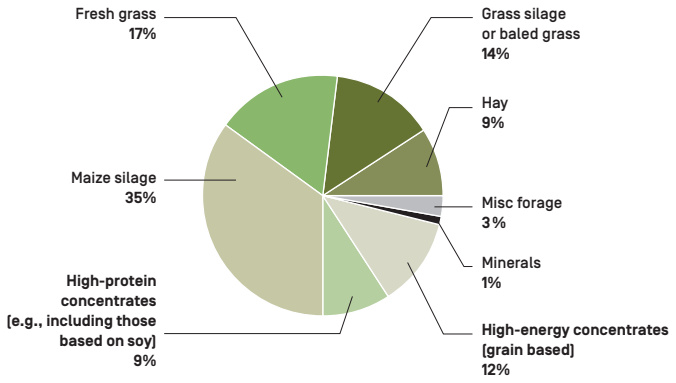
GRAZING CYCLE
1-2 day rotation

AVERAGE ANNUAL DURATION OF MILK PRODUCTION (LACTATION)
10 months

AVERAGE YIELD/HEAD/YEAR
7060 L

Sources : CNIEL (Le pâturage des vaches laitières françaises - 2019), Résultats contrôle laitier - 2019, Économie laitière 2020, Donnée Res'alim®)

CHARACTERISTICS OF DAIRY COW RATIONS



↑ While overwintering, cows may continue to receive grass in the form of hay, silage, or baled grass.

TERMINOLOGY

Intensive or extensive? Defining important terms

When we talk about intensive dairy farming, are we referring to milk yield per animal or per hectare of resources? The definition we use makes a difference when assessing impacts on the environment and animal welfare.

"Intensive farming may involve situations with a high target yield per cow (>12,000 litres per year), where the animals live indoors in large herds that have no access to pastures", explains Jean-Louis Peyraud, special adviser at INRAE's Scientific Directorate for Agriculture. That said, certain grass-based systems can also be intensive. For example, New Zealand has dairy herds that number around 400-1,000 head (source: IFCN Dairy Report 2020). They graze on grasslands maintained via very high levels of irrigation, *"yet milk production per cow remains moderate, around 6,000 litres/year",* remarks Jean-Louis Peyraud. In contrast, extensive farming aims to limit inputs (e.g., fuel oil, forage, feed) and better balances herd density and grassland production potential. Grasslands can be cut and harvested to provide fodder to livestock kept in enclosures, as occurs on some organically certified farms in Denmark. Production systems could be more readily compared by examining the relative balance between animal density and farm resources (e.g., hectares of pasture, forage, and fertilised land or ecosystem diversity). ●

MEETING ECONOMIC DEMANDS WITHOUT INCREASING ENVIRONMENTAL IMPACTS

Worldwide, the dairy industry is grappling with a steady increase in demand of about 15 to 18 billion litres each year. At the same time, it is attempting to mitigate its environmental impacts. The industry is also facing growing societal expectations around animal welfare, particularly in Western countries. Navigating these challenges is essential to strike a healthy balance between competitiveness and sustainability.

At the global scale, cow feed costs represent 65% of milk production costs, according to the report World mapping of animal feeding systems in the dairy sector (FAO, IDF, IFCN, 2014). Consequently, farms must deal with fluctuating input prices, particularly those of concentrates, which leads to variability in milk's cost price. However, the money that farmers receive depends on the contracts they have established and is set by the milk collection and processing industries. It is shaped by supply and demand within the highly competitive global milk market, even if only 9% of production is imported/exported, according to the Centre national interprofessionnel de l'économie laitière (CNIEL).

The global market determines product profitability

Thus, while the dairy industry's annual sales amount to nearly 50 billion euros, there are dramatic disparities in farmers' incomes and profits. "*This phenomenon is pronounced within the European Union. As there are no customs duties, all of the EU's farmers are in direct competition with each other, and the largest exporting country sets prices*", explains Vincent Chatellier, an economist who studies agricultural structures, markets, resources, and regions (INRAE Centre of Brittany-Normandy). On April 1, 2015, the Common Agricultural Policy (CAP) ended dairy quotas, a policy tool that had helped limit each member state's output. This shift marked the end of guaranteed purchase prices for producers. Some countries, such as Ireland, Germany, and the Netherlands, responded by producing more dairy products for export, which has led to overproduction and lower prices. *"France has chosen to maintain its diverse production methods and regions but has consequently lost market share in Europe",* says Vincent Chatellier.

Although France remains the number two producer in Europe, with a stable output of around 25.1 billion litres (CNIEL, 2020), profitability varies substantially among French dairy farms. Conventional dairies frequently face sudden market shifts and sometimes sell at a loss. In contrast, farms operating under certain certification schemes (PDO cheeses, organic milk) or labelling regimes *(e.g., C'est qui le Patron, Lait de montagne, Lait de foin, Lait de nos régions)* often benefit from greater stability.

Average dairy product consumption

Worldwide
113 L

USA & UE
270-290 L

China
35-45 L

France
290-305 L

India
105-115 L

(in volumetric milk equivalents per person per year)

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Contrasting environmental impacts

The intensification of dairy farming has required ever growing quantities of inputs (e.g., fuel oil, fertiliser, commercial feed), leading to greater environmental impacts. In 2010, EU dairy production generated an equivalent of 176-241 million tons of CO_2, which represents 0.05% of global emissions of greenhouse gases (GHG[1], CH_4, N_2O and CO_2). Farms are key GHG sources because they utilise ruminant livestock, apply petrochemical fertilisers, produce food, and consume energy. Livestock farming specifically contributes because it relies on imported soybean oil cakes, which improve the protein content of the animals' diets, based as they are on maize silage rations. Such provokes land use changes that harm biodiversity and ecosystems. In some areas, animal densities are high, grazing is poorly managed, and manure is applied too frequently. Thus, dairy farming can contribute to excessive levels of nitrogen and phosphorus fertilisation.

Such results in the pollution of rivers and phreatic zones, a phenomenon that continues despite regulatory efforts, notably the 1991 EU Nitrates Directive. The latter's effects remain mixed. However, in areas where it is still practiced, ruminant grazing helps preserve permanent or sown grasslands. In addition to boosting the attractiveness of regional landscapes, grazing has other benefits. By maintaining grasslands, it is possible to limit soil erosion, regulate water flows, and cleanse mineral and organic pollutants. *"Grazing can also reduce the net GHG emissions released by livestock farming. Grasslands are almost as effective as forests at sequestering carbon in the soil"*, explains Luc Delaby, an animal husbandry scientist in the Joint Research Unit for the Physiology, Environment, and Genetics for the Animal and Livestock Systems (PEGASE) at the INRAE Centre of Brittany- →

↑ **With their high-level know-how and reputation for quality, French producers are leading in dairy exports. Of key importance are their cheeses, which generated over €2.5 billion in revenue in 2019.**

1. Direct and indirect emissions, percentage calculated based on data from *Rôles, impacts et services issus des élevages en Europe*, 2016.

Grasslands reduce net GHG emissions from livestock production systems by sequestering carbon in the soil.

↑
Grass-based dairy farming: services and impacts While still responsible for net GHG emissions, grass-based livestock systems reduce levels of petrochemical inputs, which are polluting and energy inefficient. Grazing thus helps preserve ecosystems and fosters cultural identity at the regional level (e.g., gastronomy, artisanship, landscapes). With proper public regulation and private local management, these practices are proving to be profitable for the agricultural and tourism industries.

Normandy. Hedges, grassy banks, and the associated bocages preserve regional biodiversity by creating habitat for wild flora, wild fauna, and microorganisms, which all play a role in various ecological cycles. They also contribute to regional resilience to climate change.

Animal welfare

Research has shown that farm animals are sentient beings[2], a fact that has been acknowledged by French and European legislators (French Rural Code, French Civil Code, Treaty of Amsterdam). Sentient animals perceive their environment to varying degrees via emotional and sensory experiences (sight, hearing, smell, taste, touch). The degree of sensitivity varies among species and individuals. Often, animal welfare is described in terms of the Five Freedoms, which focus on well-being as it relates to physiological, environmental, health, behavioural, and psychological conditions. These freedoms are described in terms of results rather than methods. For example, cows must experience freedom from prolonged hunger or thirst. They must also be protected against excessively high temperatures (e.g., be housed in a ventilated facility, have access to shade). At temperatures above 25°C, cows experience thermal stress. Indoor and outdoor environments need to be designed so as to allow animals to move around freely and to lie down as necessary. These facets of animal welfare are quantifiable and thus easy to characterise. Societal expectations around animal welfare are growing ever greater. In 2019, 94% of Europeans considered this issue to be important and stated that it influences their purchasing decisions (source: Eurobarometer). *"Grazing is viewed positively by society. People associate it with more natural production systems and perceive it as improving animal welfare"*, says Luc Delaby. However, it is essential to consider how animals experience grazing rather than simply adopting an anthropomorphic perspective. Scientists and industry stakeholders are thus seeking to develop environments and conditions that allow animals to express species-specific behaviours that promote well-being: social interactions, dietary choices, and educating their young. However, whether at the level of the farm or the globe, it is challenging to strike the right balance between profits, environmental impacts, and animal welfare.

Bundles of services

To promote progress, scientists have proposed thinking in terms of bundles of services, where a distinction is made between positive and negative impacts. Such is accomplished via the concept of *La Grange*, which holistically describes how farms within a region interact with the market (worldwide or locally), generate direct or indirect employment, are dependent on inputs from other regions, and provide environmental and cultural services. *"Livestock farming is thus evaluated for all the services it generates and not strictly from the quantifiable perspective of production, which allows agricultural strategies to be adapted to regional and planetary resources and constraints"*, comments Bertrand Dumont, an animal husbandry scientist with the Joint Research Unit for Herbivores at the INRAE Centre of Clermont-Auvergne-Rhône-Alpes. ●

2. INRAE, 2009, Douleurs animales: les identifier, les comprendre, les limiter chez les animaux d'élevage. INRAE, 2017, La conscience animale.

IMPORTANT ISSUES

Antibiotics and anti-parasitics: how do we reduce usage?

Ensuring animal health is one of the five essential freedoms and often involves the use of antibiotics and antiparasitics. However, dosage levels that are excessive or insufficient can lead to the emergence of resistant bacteria and/or parasites as well as to environmental pollution. Indeed, France's first Ecoantibio Programme (2012–2017) encouraged stakeholders to take a preventive rather than a curative approach. Such involves adopting good hygiene and breeding practices.

The use of these products has declined 37% thanks to farmers increasing the cleanliness of their facilities, vaccinating their animals, and targeting sick individuals rather than entire herds for isolation and treatment. Unfortunately, this concern is not shared by all other countries, especially those that still allow the use of antibiotics as "growth promoters". This practice was banned in the EU in 2006 but remains authorised in the Americas and China.

ECONOMY

Cattle dairy production

WORLD

TOP 3 MILK PRODUCERS WORLDWIDE

1 UE
2 USA
3 India

The EU exports 12% of its cow's milk to global markets, mainly to Asia and, to a lesser extent, to Africa.

VOLUMETRIC MILK PRODUCTION (UE-27- 2018)

151.3 billion litres

or 20% of global production

EUROPE

TOP 3 EU PRODUCERS
(in billions of L)

TOP 3 EXPORTERS OF DAIRY PRODUCTS
(in billions of €)

(source : Cniel - Économie Laitère 2020)

GRASS-BASED LIVESTOCK FARMING, RARING TO SUCCEED

In Europe, including in France, some pastoral systems and mixed systems are striving for 100% grass-based production to increase profitability and/or develop more environmentally friendly practices. However, given the advent of climate change, are grass-fed systems a safe bet?

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Research has confirmed that grass provides cows with a ration that is fully balanced in energy and proteins. Grazing is also a more affordable approach for farmers. Furthermore, *"fresh grass meets 90% of a cow's hydration needs. For example, a cow drinks 10 litres per day when grazing versus 60 litres per day when consuming maize silage"*, notes Jean-Louis Peyraud, a special adviser at INRAE's Scientific Directorate for Agriculture. When processed for longer-term conservation (i.e., hay, grass silage, baled grass), grass declines in nutritional quality. Farmers must supplement their herd's diet with concentrates, especially grain-based concentrates, in order to maintain milk production. The approach then becomes less economically attractive, especially since it is more challenging to harvest and store grass than maize silage. Grassland systems should thus maximise grazing. In addition, by using greater quantities of legumes, farmers can spend less money on mineral fertilisers. Furthermore, grasslands can be maintained without plant protection products. Savings are also achieved via lowered seed costs—grasslands are sown once every several years, or not at all in the case of permanent grasslands.

Strong potential for profitability

In France, farmers who utilise grass-based production systems can benefit financially if they become certified under certain regimes/labelling schemes, which often require that animals be grass fed. For example, in 2019, organic farmers could sell 1,000 litres of milk for €434, on average; the same quantity of conventionally produced milk went for €372.

It should be noted that various minor European initiatives are seeking to commercially categorise "grass milk" based on its origin and production conditions (e.g., labels for "haymilk" or "grassland milk"). Such could increase the decision-making power of consumers while also ensuring that farmers receive fair compensation relative to true production costs.

Diverse grasslands provide diverse environmental services

On grass-based livestock farms, there is a range of floristic diversity. *"Farms can use three types of grassland for grazing and/or for mowing. In the latter case, fodder can be conserved as hay, baled grass, or grass silage",* explains Luc Delaby, an animal husbandry scientist in the Joint Research Unit PEGASE. Legume grasslands are sown and last for short periods of time (1–3 years). They contain one or more species; most are 90% lucerne, which sometimes co-occurs with sainfoin or clover. Temporary grasslands are also sown but last for longer periods of time (5–10 years). They contain a broader diversity of grasses (e.g., perennial ryegrass, annual ryegrass, tall fescue, orchard grass), legumes, and various dicotyledons. Permanent grasslands are not sown. Instead, livestock farmers exploit the native flora specific to the soils and climatic conditions of their region. *"These permanent grasslands are often characterised by plots that are highly rich in species (from 15 to more than 100). Their environmental benefits are thus enormous"*, says Luc Delaby.

The environmental advantages of sown grasslands (e.g., biodiversity, carbon storage, water purification) generally accrue the longer grasslands remain in place. To promote agroecological practices, an agricultural competition was launched. Over the past 10 years, Prairies Fleuries has been granting awards to French farms whose livestock systems display the best balance between grassland floristic diversity, forage autonomy, and product quality. Grasslands also help limit soil erosion because they result in year-round plant cover.

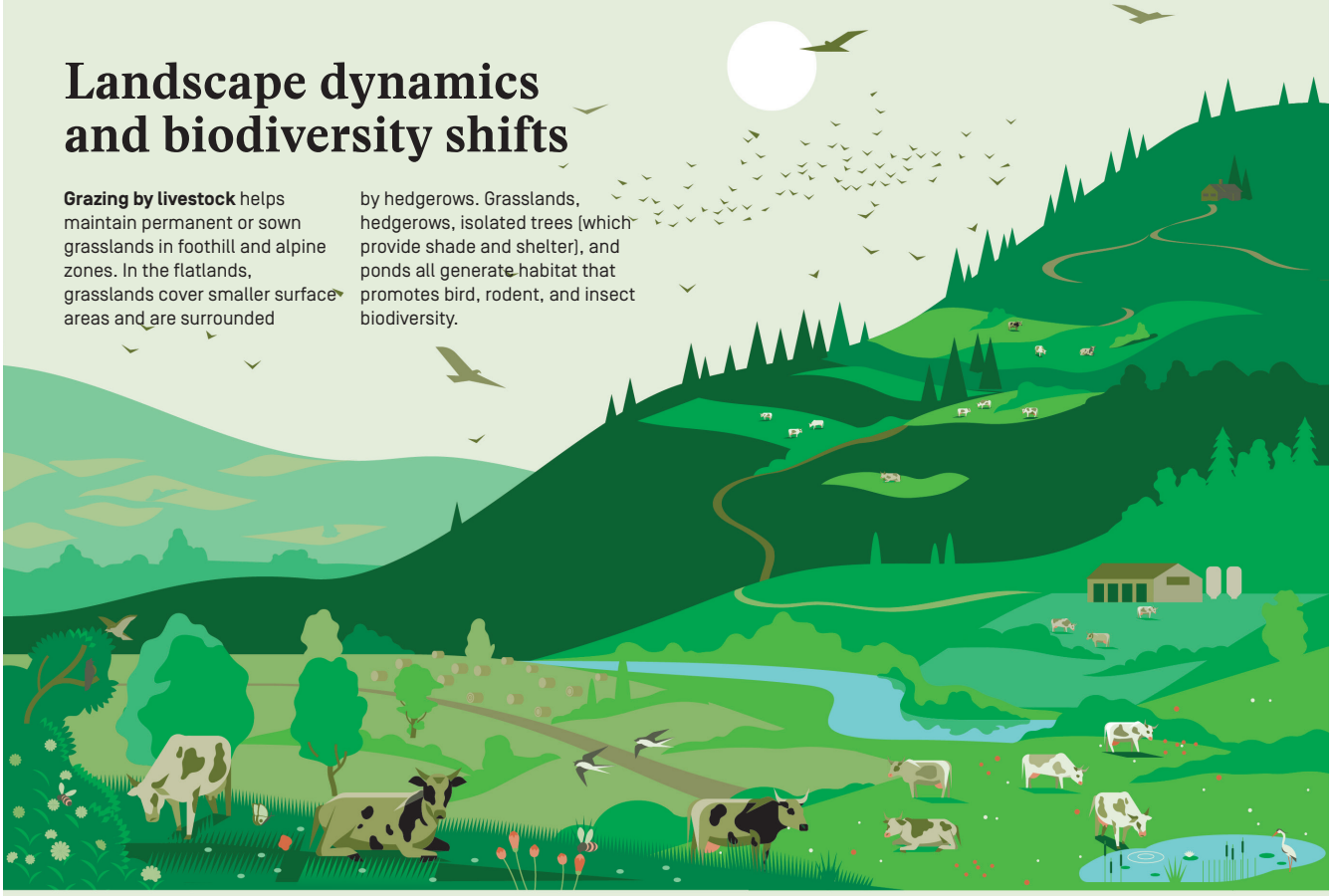
High-quality dairy products

The forage consumed by dairy cows has an impact on the nutritional and organoleptic characteristics of dairy products. As Bruno Martin, an animal →

The environmental advantages of sown grasslands generally accrue the longer grasslands remain in place.

Landscape dynamics and biodiversity shifts

Grazing by livestock helps maintain permanent or sown grasslands in foothill and alpine zones. In the flatlands, grasslands cover smaller surface areas and are surrounded by hedgerows. Grasslands, hedgerows, isolated trees (which provide shade and shelter), and ponds all generate habitat that promotes bird, rodent, and insect biodiversity.



In the absence of grazing, at higher elevations, forests or uncultivated fields spread via spontaneous regeneration. Monoculture tree plantations may also be established. The marked plant and animal biodiversity found in grasslands disappears. It is replaced by that associated with forests, which can be significantly lower.

In the countryside, arable land is dedicated to monocultures of food crops or to bioenergy production. The expanses formerly covered by hedgerows, trees, and ponds are shrinking to facilitate mechanised harvesting. There has thus been a concomitant reduction in the fauna that these lands harbour.

husbandry scientist in the Joint Research Unit for Herbivores, explains, *"Regardless of grassland origin, the more grass present in the ration, the richer the milk will be in vitamin A, vitamin E, ß-carotene, and omega-3. This milk also has lower levels of saturated fat compared to milk produced by cows fed corn silage."* To a lesser extent, similar effects are observed when animals are given grass in the form of hay or silage. *"These compositional differences carry through into the final products, such as butter, cream, and cheese, influencing their flavour, colour, and texture",* says Bruno Martin. However, the effects of grass-based diets depend on grass developmental stage, the storage conditions experienced by winter forage (i.e., hay silage), and grassland plant diversity.

Benefits of grazing for animal welfare

Grazing can also improve animal welfare. It allows animals to freely express natural behaviours and food preferences. In addition, some grassland plants are rich in carotenoids and tannins. They have been shown to positively affect animal health by reducing the risk of mastitis or metritis. However, to optimally exploit grasslands, it is important to establish clear paths for animals to walk along and to plant hedges for shade.

Constraints and fine-scale management

"Farmers must closely and precisely monitor grassland growth and species composition when implementing production systems where dairy cows graze on permanent or legume grasslands. It is also crucial that animal density (i.e., the stocking rate) match plot surface area if farmers wish to fully benefit from the grazing regime", warns Luc Delaby. Such requires managing grass quantities, which vary greatly depending on climatic conditions (i.e., temperature, rainfall). Climate change is likely to render management even more challenging, given that extreme droughts and precipitation events will become increasingly frequent and intense. One strategy could be to sow certain types of species, such as those with deeper roots and greater resilience. Luc Delaby provides some reassurance: *"It is important to remember that grass provides year-round ground cover and will grow more or less abundantly depending on the weather, which completely contrasts with annual forage crops, which are sown and harvested once a year. If the summer is too dry and a farmer has to resort to their forage reserves (i.e., hay, silage, haylage), they can compensate for the situation by producing grass late in the fall, over the winter, or even early the following spring. On the other hand, if a drought harms forage crop yields, a farmer will be forced to purchase rations for their livestock."*

Renewed interest in grass-based systems also means renewed interest in "hardy" livestock breeds that are well adapted to the environment, less bulky in stature, and able to do without concentrates. Highly productive breeds, such as the Holstein, generally do well in low-intensity, grass-based systems. However, their reproductive performance is sometimes impacted. Indeed, selection for certain traits such as size and milk production means that these breeds now struggle with milk production and gestation if they are not fed concentrates during their reproductive period. Grazing is the sole or mostly dominant system used in some countries, such as Ireland and New Zealand. However, in the lowlands and foothills of most of Europe, farmers employ mixed crop-livestock systems with lower levels of grazing, higher levels of annual forage crops (especially maize silage), and concentrate supplementation.

Farms are increasing in surface area, with pastures that are located farther and farther away from milking parlours. This shift has made grazing management more challenging, especially because herd sizes are generally increasing as well. →

Farmers must closely and precisely monitor grassland growth and species composition when implementing dairy production systems.

Contributions by geographers Thibaut Preux (University of Poitiers, RURALITES) and Laurent Rieutort (Joint Research Unit Territoires, University of Clermont-Auvergne-INRAE-APT-VAS)

↳ It is essential to understand grass growth patterns to customise grazing strategies.

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Practical constraints

In addition, as agricultural lands are being transformed into urban developments or transportation routes (i.e., roads, railroads), rural areas are disappearing and becoming fragmented. Since cows need to be milked once or twice a day, grazing becomes untenable given pasture distance. The result is less fresh grass in the cows' diets. Robotic milking systems have also led to a reduced use of grazing.

Livestock farmers are facing an additional challenge as farmlands are increasingly being dedicated to non-food crops (e.g., crops destined for energy production or green chemistry). Such crops may be more profitable in certain regions, driving up forage prices and thus threatening the economic balance of dairy farms. All these issues must be addressed when decision-makers develop and implement public policies.

A collaborative commitment to protecting the environment

Although there are some concerns to keep in mind, a well-managed grazing regime can benefit dairy farmers and the environment in distinct ways. The EU has codified certain goals in its Green Deal: a) becoming the first climate-neutral continent by 2050 and b) structuring the 2021–2027 CAP to encourage a return to grazing by providing direct aid to farmers that is conditioned on the adoption of agroecological practices (e.g., increasing plant cover diversity, reducing ploughing, and limiting the use of phytosanitary products). Additional subsidies may be granted based on the environmental and animal welfare services provided by grasslands and associated agroecological infrastructures. Alongside farmers and decision-makers, consumers have a determinant role in this economy: their purchasing choices support or reject grass-based production systems. ●

EXPERIMENTS IN THE FIELD!

Challenges vary among regions in France. Consequently, INRAE has long been experimenting with innovative grass-based dairy production models. The objective is to identify helpful tools and difficult obstacles as well as to gather information that can inform efforts to adapt practices, livestock systems, and industries. Here, we take a closer look at seven experiments.

MEMIPAT

Auvergne

"Optimising grassland characteristics via mixed grazing"

Study led by Frédéric Joly, agroecologist in the Joint Research Unit for Herbivores (INRAE Centre of Clermont-Auvergne-Rhône-Alpes).

Traditionally, Europe has largely used a successive multispecies grazing regime: cows graze a plot first, and then sheep take their turn. However, in nature, large grassy areas like savannahs host wildlife species of different sizes that display diverse feeding behaviours. The MeMiPat project applied this observation to an agricultural context and explored the impacts of mixed grazing with ewe lambs and Holstein heifers. The latter have a docile nature, making them well suited to such systems. The project's objective was to describe the individual feeding behaviour of each species and the animals' combined impact on grasslands. Cows are less selective foragers, and they graze on tall grasses. The ewe lambs can thus consume the more nutritious. low-lying grasses. This system promotes more effective grassland use and improves lamb health. Ewe lambs are frequently infected with strongyles, parasites that are prevalent in ruminants reared outdoors. However, compared to control animals, ewe lambs in mixed grazing systems were less likely to become infected and grew twice as fast.

2019-2020

Herd
10
cows
86
ewes

Pasture - 13 ha
165 days / year
continuous system

Ration
100%
grazed grass

© Frédéric Joly / INRAE

2020-2025

Herd

14
Holstein cows

14
Montbéliarde cows

Pasture - 27 ha

200 days/ year
Rotating system (1 day)

Ration
100 % grass, grazed and mowed

Yield/head
5 000 L
over 12 months

COCCINELLE

Grasslands of Auvergne

"Co-constructing sustainable alpine livestock farming systems that promote animal welfare and product quality"

Study led by Matthieu Bouchon, Dominique Pomiès, and four other animal husbandry scientists in the Low Mountain Ruminant Farming Systems Facility (Herbipôle) and the Joint Research Unit for Herbivores (INRAE Centre of Clermont-Auvergne-Rhône-Alpes).

Developed in collaboration with industry and environmentally minded stakeholders, this project explores an alpine dairy production system with a focus on incorporating public expectations around product quality, improving animal welfare, and boosting environmental sustainability. It builds on 20 years of experiments demonstrating how grazing in floristically diverse, high-altitude grasslands (containing 30–80 species) positively impacts the quality of milk and cheese, which end up with high levels of omega-3 fatty acids and low levels of saturated fat. The aim is to develop a 100% grass-based system that is low in inputs. The life cycle of the animals (i.e., reproduction, calving, growth, lactation) is organised around grassland growth, such that grazing alone allows summer food needs to be met. The calves are born in the spring and remain with their mothers until weaning. They thus benefit from the grassland from a young age. Regardless of when cutting occurs, permanent grasslands maximise biodiversity while producing different hay types that are adapted to the animals' winter needs. Using a participatory research approach, the project team reached out to a local collective of livestock farmers to obtain guidance on the experiment's future technical choices around crossbreeding, lengthening lactation duration, and testing crop suitability as winter feed for cattle grazed in alpine regions.

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→ Researchers are characterising the floral diversity of alpine grasslands to understand its impacts on milk quality.

© Luc Delaby/INRAE

← Farmers can graze large herds, provided they have land that is accessible and in good condition.

TRIPL'XL

Plains of Normandy

"Lowering milk production costs by putting large herds out to pasture"

Study led by Luc Delaby, an animal husbandry scientist in the Joint Research Unit for the Physiology, Environment, and Genetics for the Animal and Livestock Systems (PEGASE, INRAE Centre of Brittany-Normandy).

Tripl'XL arose out of 30 years of experimental research on dairy production systems near Pin-au-Haras in northwestern France. This work quantified the value of grazed grass, the impacts of its forms of usage, and the compatibility of certain dairy breeds with certain grassland systems. The project is exploring the ways in which farmers with large herds can return to plains-based grazing systems. The research is being carried out with collaborators in Ireland, a country known for its low-cost dairy production. As a result, 150 dairy cows are grazing on 10 ha of grassland in accordance with a plan that was adjusted via Patur'Plan grazing management software, which was developed by INRAE and the company ElvUp. During the winter or if summer forage is lacking, the cows are fed grass silage and hay produced on the farm. Breeding takes place over a short period (3 months) so that calving coincides with spring grass growth. To assess the effects on milk quantity and the benefits for reproduction, cows receive moderate amounts of concentrates at certain points during lactation. The project is examining the impacts of grazing on animal health and welfare using a participatory science approach. This work is occurring cooperatively with industry stakeholders and everyday citizens via the Regional Innovation Laboratory for Livestock Farming in the west of France (LIT Ouesterel).

2020-2025

Herd

50
Holstein cows

50
Normande cows

50
Jersey cows

Pasture - 82 ha
220 days/ year
Rotating system (8-12 days)

Ration
100 % grazed grass, grass silage, haylage
+
350 kg of concentrates on average/cow/year

Yield/head
4 000 to 8 000 L
over 10 months

DYNAMIX

Ariège

“Mixed crop-livestock systems: reflecting collaboratively at regional scales”

Serious game created by Julie Ryschawy, agricultural scientist in the Joint Research Unit for Agroecology, Innovations and Territories (AGIR, INRAE Centre of Occitanie-Toulouse).

In Ariège, there is agricultural segregation in space: livestock farms are found on the piedmont slopes, while farms growing grain crops occur on the plains. While these specialised farms are thus distanced from each other, they could nonetheless re-establish synergistic relationships by building adapted supply chains. Dynamix is exploring a participatory approach to reforging links between livestock farmers and grain farmers. The project has developed a board game that players can use to design buying and selling scenarios for grains, forage, and manure. They have game pieces labelled “supply”, “demand” and “logistics”. The method incites collective reflection at the plot level, farm level, and regional level. By combining different evaluation software programmes that utilise real-life data, the game’s modelling system makes it possible to estimate scenario-specific gains in working time and costs. This multicriteria approach is a reliable decision-making tool. Players can answer the following questions: what gains will result for this scenario? Which criteria will improve? Which will degrade? This game-based approach was tested by the Ariège Chamber of Agriculture between 2017 and 2020, but its reach may extend beyond France. Indeed, agricultural stakeholders in Scotland, Denmark, the US (California), and Brazil are all exploring its utility.

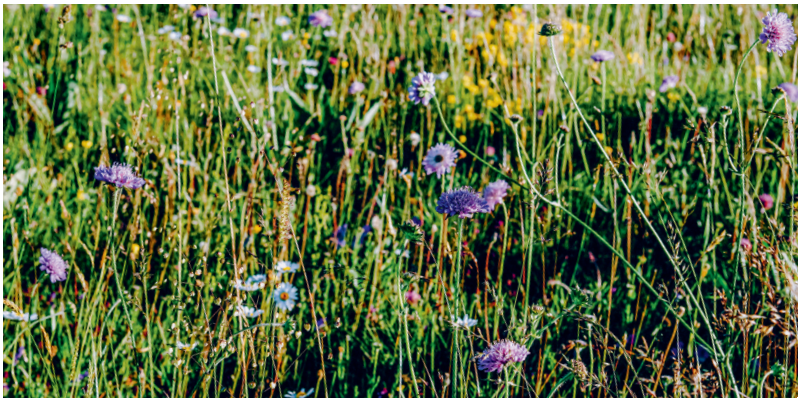
MULTISWARD

Europe

“Multispecies grasslands for sustainable livestock production in Europe”

Study led by Jean-Louis Peyraud, Special adviser at INRAE's Scientific Directorate for Agriculture and agricultural scientist in the Joint Research Unit for the Physiology, Environment, and Genetics for the Animal and Livestock Systems (PEGASE, INRAE Centre of Brittany-Normandy).

Between 2010 and 2014, the MultiSward project assessed the use and management of multispecies grasslands composed of grass-and-legume associations in different European farming systems. Fifteen partners evaluated metrics for plant cover, milk production, (and meat production) for a variety of grazing regimes in 10 European countries with different soil, climatic, and socioeconomic conditions. The countries studied ranged from France to Poland and from Italy to Norway. The results have shown that grasslands are advantageous because they boost land productivity while also generating environmental benefits. The scientists quantified the economic, agricultural, and nutritional advantages of different setups, providing support for the idea that herbivores can be sustainably farmed. The project’s findings are available in a free book. The goal is to promote reflection on the different grass-based production models used in Europe.



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← Cow grazing on a plot containing sorghum (an African grain) and lablab (a tropical legume) during a drought, when the grass supply cannot meet animals' needs.

OASYS

Plains of Poitevin

"Diversifying cover crops to allow year-round grazing even when summer forage is lacking"

Study led by Sandra Novak, agricultural scientist in the Lusignan Experimental Unit for Forage, Ruminants, and Environment (FERLUS, INRAE Centre of Nouvelle-Aquitaine-Poitiers.

Oasys is developing a mixed crop-livestock system in which animals graze on diverse cover crops throughout the year. The objective is to produce milk using water- and energy-efficient practices. The project is taking place in western central France. This area's oceanic climate, characterised by marked summer droughts, prefigures conditions expected in 2050 in France's Grand-Ouest region. The latter is responsible for 50% of French milk production. Oasys aims to align the animals' nutritional needs with grassland availability via an adapted farming strategy that utilises reproduction, cross-breeding, and lengthened lactation. During periods of drought or in the winter, part of the herd is dried off to reduce forage needs. Animals graze on suitable cover crops (millet & clover, sorghum, maslin, chicory, and beets) in addition to consuming conserved forage. This work is also testing the utility of fodder trees, which provide shade and food, in an agroforestry system that is one-of-a-kind in Europe. It is composed of 200 pollarded trees, 1,600 fodder vines, and 600 shrubs, forming an arboretum where it is possible to evaluate the nutritional value of leaves from 50 tree species and thus meet the demands of livestock farmers.

2013-2033

Herd
72
Swedish Red x Jersey/Holstein cows

Pasture 48 ha
270 days/year
Rotating system (3-4 days)

Ration
50% grazed cover crops and 50% conserved forage

Yield/head
6,500 L
over 12 months

since 2016

Herd
36
Holstein cows

36
Montbéliarde cows

18
Cross-bred dairy cows

Pasture - 170 ha
250 days/ year
Rotating system

Ration
100 % grass, grazed and mowed

Yield/head
3,900 L
over 12-16 months

ASTER

Plateau of Lorraine

"From organic dairy production to multicrop, multi-livestock systems"

Research led by Amandine Durpoix and Laurent Brunet alongside other engineers and research technicians at the Research Unit for Agroecosystems, Territories, and Resources (ASTER, INRAE Centre of Grand Ouest-Nancy).

ASTER is exploring the self-sufficiency and sustainability of mixed crop-livestock systems using a step-by-step design method that adapts to any constraints encountered.
Between 2006 and 2015, the team compared two organic dairy systems, one based entirely on grass and the other utilising mixed crop-livestock practices. Their findings underscored the economic profitability of lower-input systems (0 fertilisers, 0 concentrates, less fuel oil). Also highlighted were their environmental benefits: increased biodiversity, reduced GHG (CH_4 and NO_2) emissions per litre of milk, and lower levels of soil nitrogen pollution. In 2016, the team built on its prior work by further diversifying its organic production systems, notably by adopting a mixed model that combined multiple crops and livestock species. Annual crops (70 ha) have been converted to species destined for human consumption (e.g., milling wheat, lentils, sunflowers, field vegetables). A flock of 130 sheep and a drove of 30 fattening pigs, all raised in the open air, have joined the herd of 90 dairy cows.
Fed exclusively on grass, the ruminants make the most of the permanent and temporary pastures, even those far from farm facilities. Sometimes grazing is mixed. The system displays several original approaches: the dairy cows are milked once a day, either indoors or out in the field, and the replacement heifers are raised by a dozen or so nurses, which reduces health issues and stimulates growth, allowing the heifers to calve at as early as 24 months.

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→ The use of a mobile milking parlour makes it possible to exploit grasslands located far from farm facilities.

FOR MORE INFORMATION

Publications

Impacts et services issus des élevages européens
A collective work edited by C. Donnars (INRAE), B. Dumont (INRAE) and P. Dupraz (INRAE-Agrocampus Ouest).
At the request of the French Ministry for the Ecological Transition, the French Ministry of Agriculture and Food Sovereignty, and ADEME, INRAE wrote up a joint scientific report on European livestock systems and their products. The document analysed their roles; their economic, social, and environmental impacts; and their commercial or non-commercial services. It drew upon an extensive review of the scientific literature. Its findings indicate that different operational tools should be used depending on the farming system.
Éditions QUAE, Sept. 2019, paper version €29.50, free ebook.
www.quae.fr

INRAE publication: Productions animales
« De grands défis et des solutions pour l'élevage »
https://productions-animales.org/issue/archive?special

L'élevage pour l'agroécologie et une alimentation durable
A collective work edited by M.-P. Elies-Oury (Bordeaux Sciences Agro – INRAE), J.-F. Hocquette (INRAE) and S. Chriki (SARA), Éditions France Agricole, November 2020, €39.
Twenty-three scientists from various renowned French scientific institutions, including INRAE, came together to write this book, whose objective is to clarify the key issues associated with livestock farming in post-modern societies. The general public is currently calling for a shared initiative referendum focused on animals. This work employs a unique form of scientific reasoning to address the current range of valid, complex concerns that have arisen in relation to livestock farming.

Expertise

Tomorrow's Livestock Farming
The scientific interest group Élevages Demain is focused on animal production systems with high levels of economic, environmental, and societal performance (ruminants, pigs, and poultry).
https://gis-elevages-demain.org/

Radio conference

De la durabilité de l'élevage

Conversation during the International Animal Production Show with Jean-Louis Peyraud, special adviser at INRAE's Scientific Directorate for Agriculture and researcher in the Joint Research Unit for the Physiology, Environment, and Genetics for the Animal and Livestock Systems (PEGASE; INRAE, Agrocampus Ouest). During this episode of Expert'ease (21 min), produced by the University of Brittany, J.-L. Peyraud discusses the role of research in moving livestock farming practices forward, current solutions, and development possibilities that promote competitiveness...and he addresses how to simultaneously act in everyone's interests..
Listen to the episode in replay on franceculture.fr 2016

En ligne

L'agriculture à la croisée des chemins

By C. Huyghe (INRAE)

We have witnessed the organic farming boom and experimental rooftop farms in cities as well as health scandals, the financial instability faced by many farmers, and environmental degradation. This context of often contradictory aspirations and demands illustrates how French agriculture seems to have reached a crossroads. In this article, Christian Huyghe, INRAE's Scientific Director for Agriculture, outlines the agricultural changes that have swept through France and identifies some tools for facilitating national transitions.

theconversation.com

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