All you can eat!

Belching bovines are blamed for being the primary culprit when it comes to greenhouse gases, but **Christine Page** argues that this is down to what and how you feed your cows

What we feed animals matters because it has profound consequences for them, us and the planet. And it's not just what they eat, but how. To understand why, we need to consider how natural systems function, how the wild ancestors of our modern domesticated animals roamed, what they ate and why the fittest survived.

Over millennia, highly complex, interdependent ecosystems evolved with intricate food webs connecting all living things. The ecosystem in which ruminants – from which we bred modern cows and sheep – evolved was complex. Plants developed a vital dual-symbiotic relationship with the microbiome of the soil as well as the ruminants that grazed them.

The basis of life for all food webs, both above and below ground, is sunlight and carbon. Everything living or once living is made of carbon, and all that carbon was once carbon dioxide in the atmosphere converted via photosynthesis into the carbon-based molecules of life. Each carbon bond is a small unit of energy captured from the sun's rays.

PHOTOSYNTHESIS: CAPTURING THE ENERGY OF SUNLIGHT

When we look at the equation for photosynthesis, we see plants use sunlight energy to transform carbon dioxide and water into glucose and oxygen:

6CO2 + 6H2O + sunlight -> C6H12O6 + 6O2

That precious glucose molecule, and the energy it holds in its carbon bonds, flows through the sap of the plant as liquid carbon. The plant uses this carbon currency to feed symbiotic soil microbes by exuding glucose through its roots, which are called root exudates. In return for being fed, the soil microbial lifecycle provides the plant with the mineral micronutrients it needs to grow via the Poop Loop (*Country Smallholding*, April 2019, 'The world beneath our wellingtons').

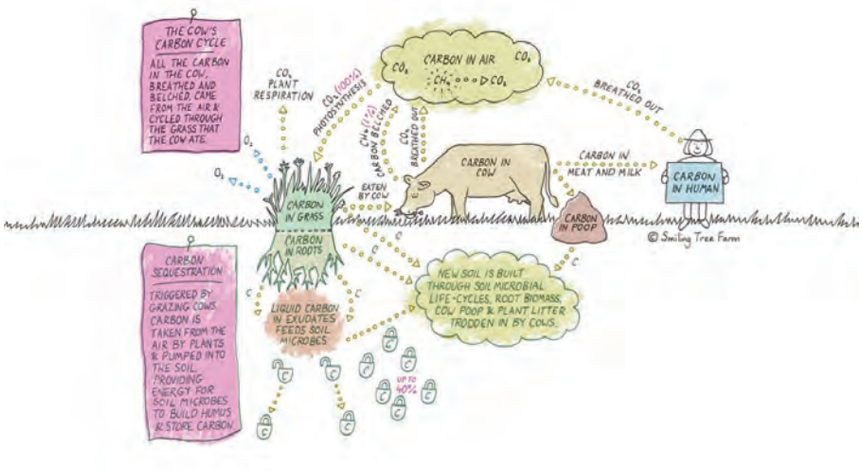
Research has shown that, through the soil-food web, up to 40% of the carbon absorbed by plants during photosynthesis is fed to soil microbes and ends up being sequestered (locked) in the soil, building humified soil organic matter as part of the soil lifecycle (*see diagram below: How carbon moves*).

ABOVE: When a cow grazes, she is feeding herself and the trillions of cellulose-fermenting microbes she carries around in her rumen

BELOW: How carbon moves

FOOD WEBS: MOVING SUNLIGHT ENERGY

When we talk about food webs, we are talking about how energy moves from the sun to the soil, transported via carbon-based molecules through the veins of plants, microbes, animals and humans, providing each along the food chain with the energy and



nutrient-transportation system necessary to survive and thrive.

Thus, when we consider what to feed animals, we must look at how we can best mimic these natural ecosystems to maximise energy capture in photosynthesis and lubricate that liquid carbon pathway.

When done using a regenerative organic system, this will sequester carbon and rebuild soils to recreate the deep, fertile soils covered in diverse flora and supporting a healthy fauna that spread around the globe before man's intervention of chemical, industrial farming. This is of particular importance when feeding ruminants because some of the deepest, most fertile soils on the planet, like the American Prairies, were created over thousands of years by grazing herds of migrating herbivores.

RUMINANTS ARE FIBRE FERMENTERS

Ruminants (cows, sheep, goats, for example) are walking biodigesters. When a cow grazes, she is not only feeding herself but also the trillions of cellulose-fermenting microbes she carries around in a large fermentation chamber called a rumen. Cellulose, another carbon-based compound and the fibrous, structural component of plants, is the most abundant organic compound on the planet. Being fibre fermenters, cows take this human-inedible substance and, through the magic of fermentation, upcycle it into highly nutrient-dense food that we can digest: meat and milk.

ABOVE: The adverse or beneficial effect on flavour and nutritional components in milk is multiplied several times for ruminants that rely on keeping a bellyful of microbes happy

However, the flavour and nutritional value of that milk and meat, as well as the health of the cow, is directly linked to what the cow eats. This is the same for all mammals, as any mum who has ever breastfed can attest. Her baby will soon make it known loudly if she has eaten or drunk something disagreeable as it passes through to her milk.

And the adverse or beneficial effect on flavour and nutritional components in milk is multiplied several times for ruminants that rely on keeping a bellyful of microbes happy. This is because, like any fermentation process, the balance of microbes and their resultant by-products directly reflect what they have to ferment.

Silvopasture

Those fibre-fermenting ruminant microbes require a natural diet of diverse pasture polycultures that include mixed hedgerows and browsing trees, known as silvopasture. This not only provides their preferred substrate, but also the diversity of plant species, each with its own array of micronutrients, giving cows the ability to self-medicate and stay healthy naturally. This innate instinct is retained from times before domestication when those animals with the greatest ability to select the most nutritious plants grew the strongest, ran the fastest and passed on their genes and behaviours to their offspring.

In return, these pastoral landscapes, with their specialist ecosystems, are reliant upon being grazed. Through millennia of symbiotic evolution, when a cow tears off blades of grass to eat, by wrapping her dextrous tongue around the leaves, she transfers billions of bacteria and enzymes in her saliva onto the torn edge of the leaf, which stimulate the grass to grow. She also ingests billions of bacteria from the soil microbiome on the pasture plants she eats.

In this way, the microbiomes of the cow and the soil are intrinsically linked. A healthy soil microbial community provides plants with the nutrients they need to grow, while a diverse, healthy plant community growing in healthy soils provides the nutrients and microbes needed by the cows to thrive. And the cows stimulate the pastures to grow and, in turn, their meat and milk provide nourishment for humans and our own gut microbiome.

Rumen microbes do not like concentrated starches such as grain, soya, fodder beet or maize, none of which are found in a natural system and all of which lower rumen pH. Or rather, some microbes do like these acidifying foods, but these are not the microbes you want in your cow's gut. Changes to rumen pH cause microbial populations to alter rapidly. The good microbes die below pH 5.4 and lactic acid builds up, leading to rumen acidosis. This not only leads to poor cow health, but it also impacts adversely

on the flavour and reduces the nutrient value of the meat or milk due to how this changes the by-products of fermentation in these acid conditions.

Furthermore, the perennial pasture, shrub and arboreal diet preferred by ruminants provides incredible wildlife habitats and uses just sunlight energy and rain to grow when part of a regenerative organic system. It doesn't need chemicals, artificial fertilisers, sprays, or require use of fossil fuels. It is replicating the natural polyculture systems of history that built fertile and functional top soils by moving carbon from the atmosphere and sequestering it in the soil via photosynthesis and microbial action.

Ecosystem services

These healthy top soils also provide essential ecosystem services, which will become ever more important as we move into the impending Grand Solar Minimum, predicted by NASA to be the lowest in 200 years. This will have an unprecedented effect on our weather as the sun cycles through this 30-year period of declining energy and magnetism. Particularly of note will be the ability of organic matter to retain water. For every extra gramme of carbon stored in the soil, the soil can hold an extra 8g of water, alleviating run-off and downstream flooding.

Conversely, to grow, harvest, transport and feed concentrated feeds like grain, soya, maize and others, requires the burning of fossil fuels and the soil-damaging and eroding practices of tillage, monoculture cropping, compaction with heavy machinery and often sprays and chemicals. All of these oxidise carbon back from the soil to the atmosphere and reduce soil fertility and function.

LEFT: Pastoral landscapes, with their specialist ecosystems, are reliant upon being grazed

ABOVE: Animals have an innate instinct to select the most nutritious plants, retained from the times before domestication

It is important to note that in our regenerative organic pastoral system, all the energy captured and transported is using carbon already flowing through the biosphere. It is cycling carbon. This is even true for the carbon in the CH_4 molecules of methane belched by the cows, which came from the grass that obtained it from the air via photosynthesis (see diagram, page 6, How carbon moves).

A vital piece of the puzzle

Having established that it is best to feed animals their natural diet of diverse perennial polyculture systems, there is one further piece of the puzzle to explain. This is a critically important piece as it is what springboards a good system into a truly regenerative one. It is the way we move the animals as they graze to replicate the beneficial impact of the great migratory herds of the world. This grazing system is referred to as mob-grazing or holistic planned grazing (see *Country Smallholding*, May 2019, 'Great green energy generators').

Soil science is still an emerging field, but there are some promising studies showing that cattle fed and holistically grazed as part of a regenerative organic pastoral system are carbon negative. That includes accounting for all emissions, including methane, and all sinks (the carbon that is removed from the atmosphere and stored). They help to sequester over three times as much carbon as the weight of beef produced.

This shows us that blaming cattle for environmental woes is unfairly binary and simplistic. It's not the cow, it's the how they are kept and what they are fed.

What we feed animals matters because it impacts their health and wellbeing as well as the flavour and nutritional value of their meat and milk. How animal feed is produced or grown can either create or destroy wildlife habitat, build and regenerate soil or erode soil, sequester carbon or emit it.

As environmentalist Wendell Berry famously said: "Eating inextricably influences agriculture." He meant that whenever you eat – whether you are conscious of it or not – you are supporting the farming methods and the industry that produced the food on your plate. Your food choices influence not only your own health and wellbeing, but also that of the farm animals and the planet.

Choose wisely, vote with your fork by purchasing food grown in regenerative, organic pastoral perennial polyculture, carbon-negative systems that produce delicious and nutritious food from contented animals fed their natural diet. ■

Christine Page owns and runs a small-scale regenerative organic pastoral farm in south Shropshire. For more information, visit www.smilingtreefarm.com