



FEEDING FARM ANIMALS WHILE SAVING THE PLANET

Mariette DiChristina^{1*} and Javier Garcia Martinez²

¹Boston University College of Communication, Boston, MA, United States

²Department of Inorganic Chemistry, Molecular Nanotechnology Lab, University of Alicante, Alicante, Spain

YOUNG REVIEWERS:



LEON

AGE: 13



STEPHANIE

AGE: 14

Insects, algae, other microorganisms, and even food waste are providing new alternative protein feeds for farm animals—while protecting the planet. These feeds are made from sustainable sources like insects, algae and other microorganisms, and even food waste. They use fewer natural resources, like land and water, and create less pollution compared to traditional options, such as soy and maize. By replacing traditional feeds, alternative protein feeds can help reduce deforestation, cut greenhouse gas emissions, and save water. Real-life examples include insects grown on food waste fed to chickens and fish, algae used in fish farming, and microorganism-based proteins providing nutrition in areas where crops are hard to grow. Challenges remain, including ramping up production and convincing farmers to switch to new feeds. Once the final hurdles are overcome, alternative protein feeds could make farming more efficient and better for the planet.

THE WORLD NEEDS GREENER WAYS TO FEED FARM ANIMALS

Farm animals like chickens, cows, and pigs provide much of the food people eat every day, including eggs, milk, and meat. But feeding all these animals has a big impact on the planet. As the global population grows, so does the demand for animal protein, putting even more pressure on natural resources like land, water, and energy.

DEFORESTATION

Cutting down large areas of forests, often to make space for farms or buildings, which harms the environment by releasing carbon and reducing habitats for wildlife.

ALTERNATIVE PROTEIN FEEDS

New types of animal feed made from sustainable sources like insects, algae, or food waste, designed to use fewer natural resources and help the environment.

SUSTAINABLE

Using resources in a way that protects the planet and ensures they will be available for future generations.

SINGLE-CELL PROTEINS

Proteins made from tiny organisms, like bacteria or algae, that can be used as food for farm animals.

BIOREACTORS

Special tanks or machines where microbes, algae, or other organisms are grown under controlled conditions to produce useful materials, like proteins or fuels.

Traditional animal feeds, such as soy, maize, and wheat, require massive amounts of these natural resources to grow. For example, **nearly 80%** of the world's soy production is used to feed animals. This high demand often leads to **deforestation**, as forests are cleared to make way for soy farms. Cutting down trees not only releases carbon stored in the soil and in plants but also reduces the planet's ability to absorb CO₂ (a greenhouse gas), making climate change worse. Growing feed crops also requires a lot of fertilizer. When it rains, excess fertilizer can wash into rivers and oceans, harming fish and other wildlife. These practices reduce biodiversity and damage ecosystems, making it clear that we need greener ways to feed farm animals. But how?

EMERGING TECHNOLOGY: ALTERNATIVE PROTEIN FEEDS

Alternative protein feeds could be a way to provide animals with the nutrition they need while using fewer natural resources and creating less environmental harm. These new types of animal feeds are made from **sustainable** resources, such as insects, algae, **single-cell proteins**, and food waste. Alternative protein feeds are high quality and nutritious, and are often created using materials that would otherwise go to waste or materials that require much less land, water, and energy to produce than traditional feeds do.

One example is algae, specifically microalgae—tiny, single-celled plant-like organisms that grow in water and are packed with protein, fats, and other nutrients. Microalgae are cultivated in tanks or ponds, where they absorb CO₂ and grow rapidly, making them a great option for animal feed [1]. Other microorganisms, like bacteria, yeast, and fungi, can also be used as sources of single-cell proteins. Like algae, these organisms can be grown in controlled environments, such as special tanks called **bioreactors** where temperature and nutrients are carefully managed—using minimal land and water. Some systems even use waste gases, like methane or CO₂, to grow these microorganisms, turning pollution into valuable protein—a great option for regions where farming traditional feed crops is challenging (To learn more about turning waste gases into useful products, read [this article](#) in this collection).

TECH TO THE RESCUE

Alternative protein feeds are already being tested and used on farms around the world (Figure 1). Global production is still small compared to soy and maize, but growing interest and investment are helping to expand this field [2, 3].

Figure 1

Alternative protein feeds, like the black soldier fly larvae being eaten by the chicken and the algae-based food eaten by the fish, provide animals with good nutrition while using fewer natural resources and protecting the environment. **(A)** Growing traditional animal feeds requires huge amounts of land, so switching to alternative protein feeds could decrease deforestation (indicated by down arrow). **(B)** Alternative protein feeds can reduce the need for fertilizers that can harm fish and other wildlife (indicated by down arrow). **(C)** Overall, production of alternative protein feeds could help to reduce greenhouse gas emissions, like CO₂, contributing to a healthier planet.

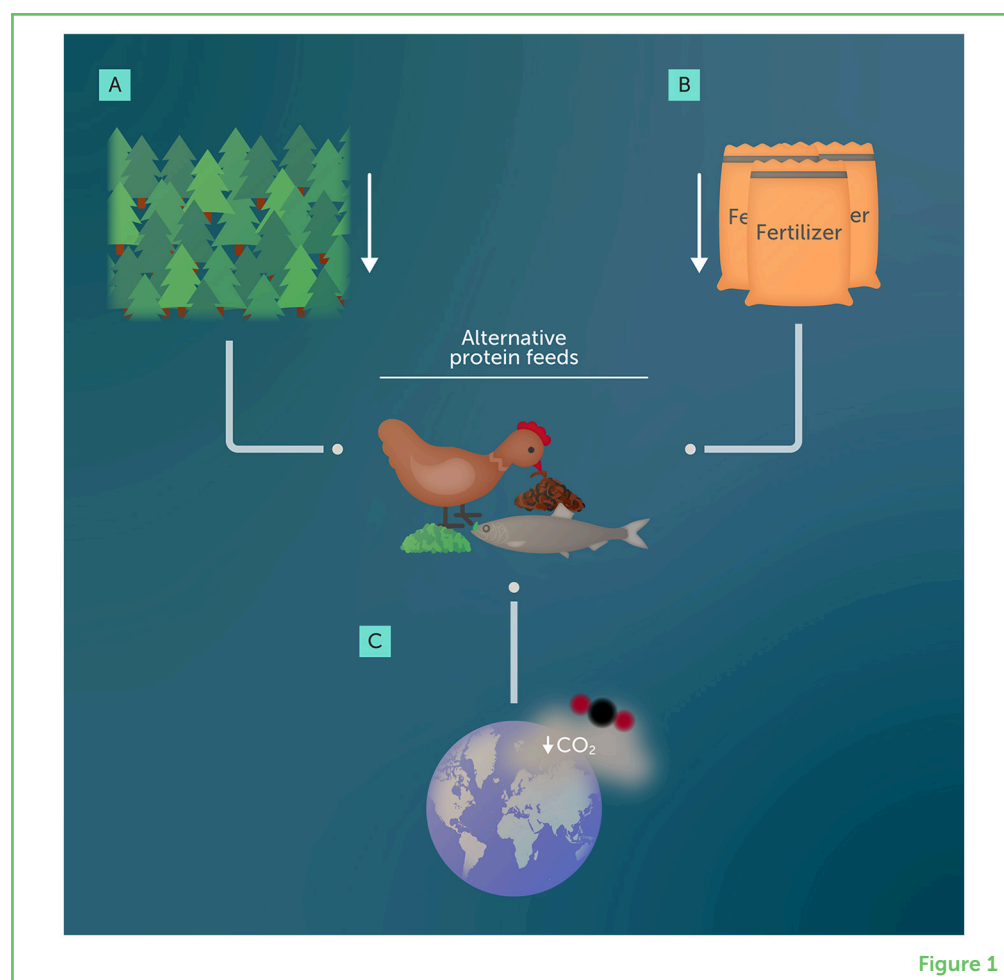


Figure 1

For example, black soldier fly larvae are being grown on food waste, like leftover fruits and vegetables from restaurants or farms [4]. These insects are rich in protein and fat, making them a healthy feed for chickens, pigs, and fish. Feeding these insects to farm animals provides high-quality nutrition while also recycling food waste that would otherwise end up in landfills. Every year, millions of tons of uneaten food are thrown away—like fruit peels, vegetable scraps, and leftovers. When food waste ends up in landfills, it decomposes and releases methane, a powerful greenhouse gas that contributes to climate change. Researchers are also exploring ways to turn waste like fruit peels, orange pulp, and vegetable scraps *directly* into animal feed [5].

Algae-based feeds are becoming popular, particularly in **aquaculture**, as a high-protein alternative to traditional fish feed. Algae grows

AQUACULTURE

The farming of fish, shellfish, or other water-dwelling animals, often done in controlled environments like tanks or ponds.

quickly in water and, like plants, it absorbs CO₂ during photosynthesis. This is a good thing—algae turns CO₂ into the energy and nutrients it needs to grow! So, growing algae can reduce CO₂ in the atmosphere, which helps to fight climate change—making it an eco-friendly choice for farmers raising fish or shellfish. Some types of algae also contain healthy fats that are essential for fish growth and well-being. Farmers are starting to use algae to supplement the diets of other farm animals, too.

Single-cell proteins, made from microbes like bacteria and yeast, are also being used as animal feed. These microbes are very easy to grow in tanks under controlled conditions and the proteins they produce can be turned into a powder that can then be mixed into animal feed, just like soybean meal. This is especially helpful in areas where traditional feed crops—like corn or soy—are hard to grow because of dry weather, poor soil, or lack of farmland. By using microbes instead of crops, farmers in these areas can still provide animals with the protein they need to stay healthy.

Alternative protein feeds can be customized for different types of farming. Fish farmers might rely on algae-based feed, while poultry farmers could use insect-based feed. This flexibility lets farmers choose the best option for their animals and farming methods, helping them save money and reduce their environmental impact.

BIG CHALLENGES, BIGGER OPPORTUNITIES

Alternative protein feeds could make farming much better for the planet, but there are still challenges to solve. One big challenge is producing enough of these feeds to supply farms worldwide. For example, growing insects like black soldier fly larvae works well on a small scale, but creating enough to feed millions of animals will require new farming systems, and tools and facilities to support large-scale production. Similarly, growing algae or single-cell proteins in large amounts can be expensive and difficult, especially without enough clean water or renewable energy.

Scientists are also studying how alternative feeds affect animals, to make sure these substances are safe, nutritious, and work well in a variety of farming systems. This includes testing how well animals grow on these diets, checking the animals' health, and making sure the nutrients in the new feeds meet their needs. More research will help fine-tune these feeds for various species, such as chickens, fish, or cows, and for different environments, like farms in hot or cold climates or places where water or space is limited.

Another challenge is convincing farmers to try these new feeds. Crops like soy and maize have been used for a long time, so switching to something new might seem risky. Scientists and companies are

working to show that alternative feeds are not only better for the environment but also safe, healthy for animals, and affordable. Clear rules and standards are needed to ensure these feeds are good for both animals and humans.

Despite these challenges, alternative protein feeds offer exciting possibilities. By reducing the need to grow traditional crops, these feeds can help save forests, use less water, and lower greenhouse gas emissions. They create opportunities for new farming ideas, like raising insects on food waste or growing tanks of single-cell proteins. These new methods could create jobs and help local communities while making farming greener and more efficient. With teamwork and new ideas, alternative protein feeds could help feed the world while protecting the planet.

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YOUNG REVIEWERS

LEON, AGE: 13

Leon is a curious 13-year-old with a passion for science, especially math, astronomy, biology, and physics. He loves exploring science fiction, particularly *The Remembrance of Earth's Past Trilogy*. Leon enjoys trying and making new foods from around the world, including Thai, Chinese, Italian, and Japanese cuisines.

STEPHANIE, AGE: 14

My name is Stephanie and I am 13 years old. I am an eighth grader in middle school and my hobbies include singing, playing tennis, and playing the clarinet. My favorite subject in school is ELA and I enjoy reading and writing mystery and dystopian stories. I have performed for the UniverSoul Circus before and I have been a reviewer for some scientific articles in this journal.

AUTHORS

MARIETTE DICHRISTINA

Mariette DiChristina is a journalist and professor who loves sharing science with the world. She is the Dean of the Boston University College of Communication, where she teaches students how to write about science and technology in ways that everyone can understand. Before becoming a professor, she was the Editor-in-Chief of *Scientific American*, one of the most famous science magazines in the world.



She has worked to make science exciting and accessible for everyone and has been recognized as a leader in science communication. *mdichris@bu.edu



JAVIER GARCIA MARTINEZ

Javier is a professor of inorganic chemistry and Director of the Molecular Nanotechnology Laboratory at the University of Alicante, Spain, where he develops new nanomaterials to make energy production more efficient and chemistry more sustainable. His work has contributed to technologies that are now widely used by laboratories and chemical companies, saving hundreds of thousands of tons of CO₂ per year. Javier has also founded a company to commercialize his discoveries. From 2022 to 2023, he was President of the International Union of Pure and Applied Chemistry (IUPAC), the organization that names molecules, curates the periodic table and promotes chemistry around the world. Javier is passionate about supporting young scientists and promoting science from an early age. He was the founding president of the Young Academy of Spain from 2019–2023, and in 2014 he created Celera, a free programme to support talented young people in Spain. More than 100 young people have benefited from this programme. His scientific contributions have been recognized with several prestigious awards including the Kathryn C. Hach Award for Entrepreneurial Success from the American Chemical Society, Honorary Fellowship of the Royal Society of Chemistry, and the National Research Award from the King of Spain.