

GENETICALLY ENGINEERED ANIMALS

From Lab to Factory Farm





Gene-edited farm animals, including cows, sheep, pigs and chicken are in the development pipeline.

Executive Summary

In the face of environmental degradation and biodiversity loss from industrial agriculture, it is critical to transition to sustainable and ecological farming systems.¹ But a new wave of research on genetically engineered animals is leading us in the opposite direction — by designing animals to better fit within industrial systems rather than addressing the underlying health, animal welfare and environmental problems associated with these systems.² A growing body of scientific evidence is finding that genetically engineered animals may present even more food safety, environmental and animal welfare issues for an already problematic industrial animal farming system.

The AquAdvantage salmon was the first genetically engineered animal approved for human consumption. Since its approval in 2015, concerns about engineering animals have only deepened. Emerging scientific literature reveals that genetic engineering techniques, including new gene editing techniques like clustered

regularly interspaced short palindromic repeats, or CRISPR, are not as precise or predictable as initially thought, and can result in unintended physical and genetic mutations that may be inhumane, risky for the health of animals and consumers and environmentally unsustainable. Gene editing techniques may be subject to little to no regulatory oversight or safety assessment.

This report provides insight on health, environmental, ethical and consumer concerns raised by the proliferation of research on genetically engineered animals. We highlight potential risks related to gene editing applications in livestock agriculture as reported in peer-reviewed scientific studies. We emphasize gaps in research and data analysis about how unintended genetic errors resulting from gene editing may impact animal welfare, human health and the environment. We also raise questions about whether gene-edited livestock are necessary, and what a more sustainable, ethical and healthy path for our food system could look like.



The impetus of genetic engineering is to design animals that survive better in factory farms.

Engineering Animals for Factory Farms

The multitude of problems associated with factory farming are unlikely to be addressed and may be exacerbated by the use of genetically engineered farm animals in these systems.

In response to the problems created by concentrated animal feeding operations, or CAFOs, and instigated by the availability of new genetic engineering techniques such as CRISPR, researchers are developing a new generation of genetically engineered farm animals. The goals of these experiments generally fall into three categories: increased yield (e.g., “super-muscly” animals), increased cost-effectiveness in raising animals (e.g., disease resistance) and changes in the composition of the milk, meat or eggs (e.g., nutrition).

Examples of genetically engineered animals in development include “super-muscly” cows, sheep and pigs;³ pigs resistant to the respiratory disease PRRSV;⁴ and gene-edited chickens engineered to potentially produce non-allergenic eggs.⁵ Some scientists argue that genetically engineered animals, such as pigs engineered to resist certain diseases, can improve animal welfare, however, the impetus is to design animals that will more easily survive in the cramped and filthy conditions common in CAFOs.

Other research explores the potential of gene drives for farm animals, a genetic engineering technology being developed to drive a desired trait through a herd or population. Although no gene drive system has yet been field tested or deployed,⁶ studies suggest that — like previous impacts from genetically modified organisms, or

GMOs — organisms might evolve to be resistant to gene drives,⁷ and the technology could give rise to off-target effects, which may have severe health, welfare and ecological implications for animals or ecosystems.⁸

Feeding the nearly 10 billion animals raised annually in U.S. factory farms requires a staggering amount of land, genetically engineered seed and toxic pesticides, fertilizer, fuel and water.⁹ Industrial animal agriculture is a leading cause of climate change, accounting for 16.5 percent of global greenhouse gas emissions.¹⁰ Raising billions of animals in confinement also generates massive amounts of noxious manure that pollute our air and water — especially in nearby communities. Routine use of antibiotics in animal agriculture that allow animals to survive the unsanitary conditions common in factory farms contributes to the rise of antibiotic resistance, one of our most pressing public health problems.



Gene-edited super-muscly animals will magnify welfare concerns currently associated with conventionally bred doubled-muscled animals.

Gene Editing and Unintended Consequences

Scientific studies have shown that the genetic engineering of animals via gene editing techniques like CRISPR and other new technologies can create unintended consequences and potentially harmful effects on animal health, from enlarged tongues to induced tumors. Yet development of genetically engineered animals is moving forward, funded by private companies or government grants, but with little public awareness.

Scientists from the Wellcome Sanger Institute in the UK published a study in *Nature*

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Biotechnology that found new genetic engineering techniques like CRISPR may cause “genetic havoc” in cells. Researchers found large deletions and rearrangements of DNA near the target site that were not intended by researchers.¹¹ Chinese scientists at Nanjing Agricultural University found that gene editing resulted in rabbits having enlarged tongues. And Dr. Kui Li, a scientist from the Chinese Academy of Agricultural Sciences, found some gene-edited pigs had an extra spinal vertebra.¹²

These studies are just a few of the growing body of science demonstrating that gene editing techniques like CRISPR may not be as “precise” in their outcomes as researchers hope. For example, gene editing could cause genes not meant to be targeted to malfunction, and this could lead to health problems or other unintended outcomes in the genetically engineered animal.¹³

Food Safety Implications

Animal genomes are complex. Any genetic errors created by altering DNA could disrupt how genes function. This could potentially produce altered or novel proteins, which in turn could impact food safety. Indeed, one scientific study by Kapahnke and others, published in *Cell* in 2016, used a laboratory culture of human cells and found an altered protein produced in error from the gene editing process.¹⁴ Because food allergens are mostly proteins, unintentionally altered proteins could have significant implications for food safety.

Animal Health and Welfare Implications

Genetic engineering of animals could magnify ethical and welfare concerns related to how animals are bred and the conditions in which they are raised.¹⁵ As part of the genetic engineering process, animals are often cloned.¹⁶ Cloning can lead to birth defects, spontaneous abortions and early postnatal death.¹⁷ Even if cloning is not involved, the genetic engineering process raises welfare issues because the animals may suffer from genetic abnormalities that could cause genes to malfunction and create subsequent health problems in the animal.¹⁸

Health problems may arise in response to mutations at the cellular level as well. Two

independent studies, one by the biotech company Novartis and the other by the Karolinska Institute, published in *Nature Medicine* in 2018 described that cells genetically engineered with CRISPR “have the potential to seed tumors,” or may initiate tumorigenic mutations.¹⁹ There is further concern that gene editing for certain traits can perpetuate problematic animal management practices. For example, a frequently-reported trait of gene-edited animals is resistance to various diseases, which could encourage keeping even larger numbers of animals in the close confinement and unsanitary, inhumane conditions that perpetuate disease in the first place.



Image: Rodrigo Gutierrez/Reuters

Genetically engineered animals could exacerbate the problems of factory farms.

Environmental Implications

Industrial animal agriculture contributes to significant levels of air, water and soil contamination. It is also a large contributor to greenhouse gas emissions. There is an urgent need to shift to models of animal farming that have inherently fewer environmental and health impacts.²⁰ However, instead of instigating this shift, the advent of genetically engineered farm animals will likely further entrench the paradigm of unsustainable, industrial agriculture and may exacerbate environmental problems associated with factory farms. In addition, genetically engineered animals may raise concerns about potential escape and crossbreeding with non-genetically engineered animals. Animals like pigs, goats, horses and rabbits may become feral when they escape from captivity,²¹ leading to wild populations of genetically engineered animals.

Consumer Rejection

Societal concerns such as animal welfare suggest that many people are likely to have even more concerns about genetically engineered animals than genetically engineered crops. This suggests that they are likely to reject genetically engineered animals on ethical and welfare grounds, regardless of their trust in the regulatory system to address food safety and environmental concerns. A recent poll found that a majority of U.S. adults believe that engineering animals “to increase protein production” is “taking technology too far.”²² Partially in response to consumer concerns, more than 80 U.S. grocery store chains have committed to not selling genetically engineered salmon, the first genetically engineered animal to enter the U.S. market and approved for human consumption.²³

Lack of Adequate Oversight and Assessment

Currently, the U.S. Food and Drug Administration (FDA) oversees the food safety aspects of genetically engineered animals,²⁴ but there are no specific regulations or guidance that cover related environmental impacts.²⁵ The U.S. has approved one genetically engineered animal for human consumption, the genetically engineered salmon, and regulates it as an “animal drug.” It was approved despite many scientists and environmental groups raising serious concerns regarding the risks of escape of the genetically engineered salmon, potential negative impacts on wild salmon populations and concerns regarding food safety. One concern is that gene-edited animals could evade regulatory oversight in the U.S. under enforcement discretion and follow the lead of Australia, which allows some gene editing techniques to be used in plants and animals and marketed as food without government regulation.²⁶

Change the Farm, Not the Animal

A growing body of science is demonstrating that genetic engineering of animals may lead to unintended consequences for food safety, animal health and welfare and the environment. Many of the “solutions” offered by genetically engineered (including gene-edited) animals are in response to problems caused by current industrial

livestock farming systems. However, genetically engineering animals will not address the root problems associated with factory farming, and in fact may entrench an unsustainable and inhumane model of livestock production.

While proponents claim there may be welfare and ecological benefits associated with some of the engineered traits, such as disease resistance or hornless cattle, these potential benefits are within the frame of intensive animal farming practices. However, small and mid-scale, high-welfare, diversified, ecologically regenerative and organic livestock production systems avoid many public health, animal welfare and environmental problems inherent in industrial animal agriculture. In addition, they have been shown to generate important ecological benefits, including carbon sequestration, soil fertility, water savings and reduced dependence on pesticides and fossil fuels.²⁷

Recent reports by the United Nations warn that to avoid ecological catastrophe, we need to rapidly transition away from industrial agriculture and reduce consumption of factory farmed meat and dairy.²⁸ Based on the studies which exemplify the uncertainty and risks from gene editing, U.S. FDA regulations need to effectively regulate all gene-edited animals to ensure the safety of animals, consumers and the environment. Rather than creating genetically engineered animals to fit into factory farms, it is critical to develop sustainable and ecological animal agriculture systems that support animal welfare, preservation and restoration of biodiversity and public health.



The real solution to problems derived from factory farming is ecological agricultural systems.

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