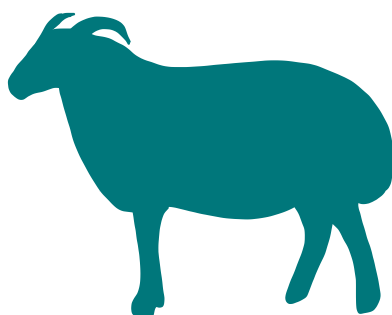
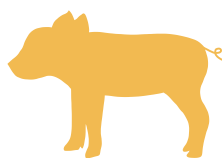
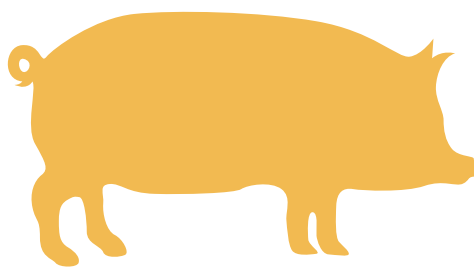


**Genome editing and
farmed animal breeding:
social and ethical issues**
**Key themes, findings, and
recommendations**

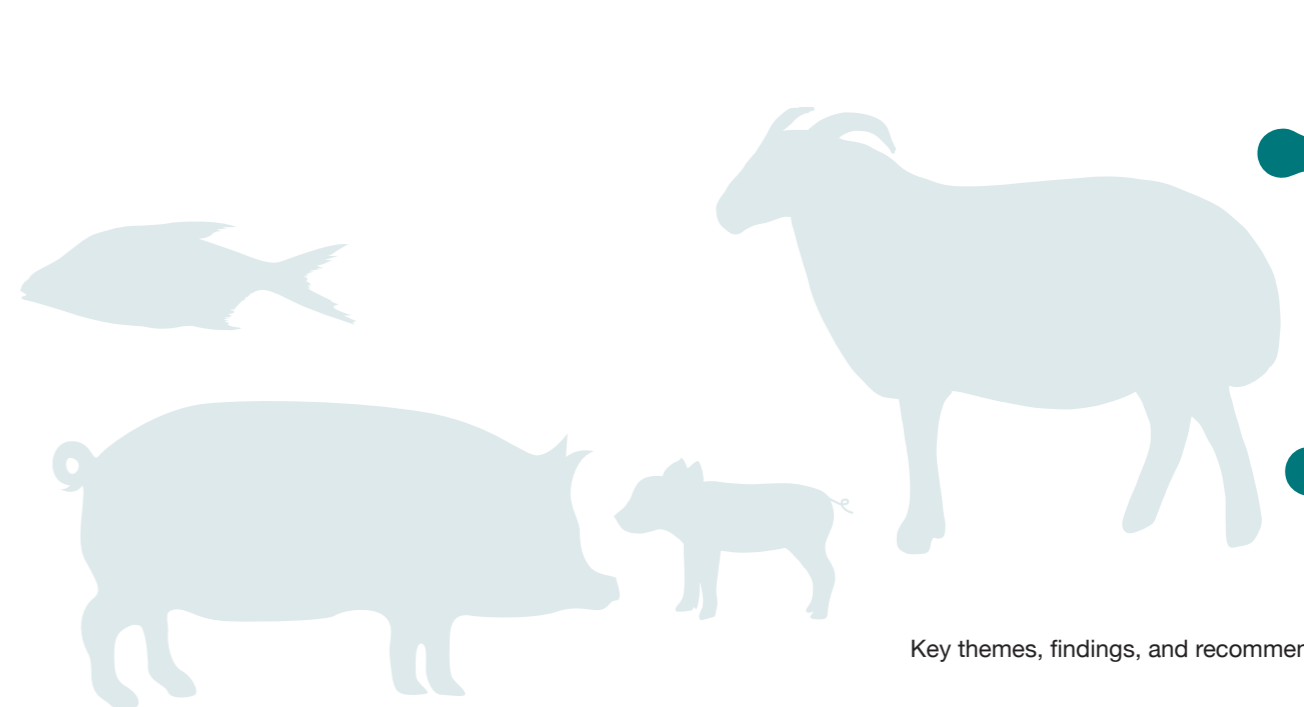
NUFFIELD
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BIOETHICS



- This short report outlines the main themes, findings and recommendations of the Nuffield Council on Bioethics' report '*Genome editing and farmed animal breeding: social and ethical issues*', which was published in December 2021.
- This inquiry was carried out by a multidisciplinary working group that included members with expertise in farming and food systems, animal biotechnology, biological research, veterinary epidemiology, law, philosophy, social science, sociology, animal welfare, and ethics.
- The working group invited contributions from a wide range of people, including through an open call for evidence, commissioned research, site visits, fact-finding meetings and a series of individual and panel interviews.
- Alongside the evidence gathering, the working group commissioned a public dialogue in which citizens were invited to explore the values and considerations that informed their response to prospective applications of genome editing in farmed animals.

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Overview and key findings

The background to this report on genome editing and farmed animal breeding begins by noting that there are currently several major challenges within our global food and farming systems, including:

- **Environmental harms caused by intensive agriculture systems.**
- **Health and welfare concerns for the animals that are bred to provide us with meat, eggs and dairy produce.**
- **Threats to human health posed by modern diets and diseases transmitted by animals in agriculture.**
- **Changes in demand due to demographic shifts like increased urbanisation and increasing levels of meat consumption in many regions of the world.**

Our report concludes that our global food and farming systems are morally indefensible and unsustainable in their present form. The ways in which we produce and consume food will have to adapt in order to address the challenges above and to provide a secure, sustainable and ethical supply of nutritious food for our growing global population.

Genome editing is the precise and targeted alteration of a DNA sequence in a living cell. Genome editing techniques offer the potential to target and alter genes in specific ways. Breeding technologies such as genome editing may have a significant role to play in food and farming systems of the future. Applications of genome editing in farmed animal breeding are aimed at producing animals with specific traits that might be difficult, or even impossible, to achieve using conventional selective breeding approaches.

New biotechnologies like genome editing offer the possibility of producing animals with traits that may, in the right circumstances, lead to improvements in animal health and welfare, for example, by increasing animals' resistance to prevalent diseases that have devastated many farming sectors in recent years. It may also help to address environmental sustainability.

However, there is also a potential for genome editing technologies to be applied without considering animals' basic interests, in a way that may compound some of the problems with historical selective breeding. An example of this would be introducing changes that enable animals to endure poorer living conditions such as overcrowding, with fewer adverse health impacts. Care must therefore be taken to ensure that the introduction of new technologies such as genome editing do not contribute to an acceleration of unethical breeding practices.

A rapid public dialogue commissioned to inform this inquiry revealed that the public generally seem more concerned about how and why new breeding technologies will be used than the nature and safety of the techniques – i.e. it is not *what* is done, but *why* it is done that matters most to them. Several people recognised the need for strong governance to ensure that any introduction of novel technologies into farmed animal breeding is aligned with people's and animals' basic interests e.g. promoting higher standards of animal welfare.

Everyone has a role to play in adapting to more sustainable systems of farming and food production, but this cannot be achieved without a governance system that promotes and encourages these changes.

We propose five principles to guide the development of food and farming systems and the introduction of new breeding technologies for farmed animals. **See page 15.**

We then make a series of recommendations including to the UK Government, animal breeders and developers, major food retailers, research funders and others involved in shaping food and farming industries both in the UK and internationally. **See pages 15 and 16.**

Introduction

See Chapter 1 of the full report

Since the 1700s, selective breeding of animals within the food and farming system has aimed to ensure agriculturally desirable features that are linked to increased productivity such as:

- **Faster growth rate**
- **Increased fertility**
- **Increased resistance to disease**
- **Better adaptation to the environment in which animals are kept**

Advances in molecular biology which have occurred since the 1970s have made it possible to alter an animal's DNA directly. These include recombinant DNA technology (which can be used to insert genes from one species into the genome of another species) and cloning (using the technique of cell nuclear transfer to make an exact genetic copy of a living thing). These techniques are not currently used in commercial animal breeding in the UK. The cloning technique has been used mostly in the development of animals for xenotransplantation (the transplantation of living cells, tissues or organs from one species to another) and the production of pharmaceutical products rather than in agricultural applications, although there are animal breeding companies offering cloning to customers. Genetically modified crops are on sale in some parts of the world.

In recent decades, the increasing sophistication and affordability of DNA sequencing techniques has made it possible to produce standard reference genomes for several species of farmed animals. Scientists have been able to identify some of the genes and variants involved in traits like disease susceptibility and physiological features such as horn growth.

Genome editing techniques offer the potential to target and alter genes in specific ways. They present new opportunities for those involved in farmed animal breeding to exercise more control over the genetic make-up of new generations of animals.

The emergence of genome editing is a significant moment, as it represents a possible step change in introducing a new generation of potentially transformative biotechnologies into the food and farming system.

The ethical and social issues raised by the use of genome editing technologies in farmed animal breeding are much broader than questions about the technique of genome editing itself. Genome editing is only one technology, recently developed, which may be supplemented or succeeded by other biological techniques as a way of achieving heritable changes in animals. Our conclusions are in this sense 'technology-neutral' and should apply equally to future breeding innovations.

Why is this report needed?

When we initiated this inquiry in 2019, we recognised that genome editing in farmed animals was a relatively near-term technology that raises distinctive ethical issues but that had received little in the way of public discussion.

During the latter part of our inquiry, in early 2021, the UK Government's Department for Environment, Food & Rural Affairs (Defra) announced a consultation setting out plans to reform existing regulations that govern the use of genetically modified organisms (GMOs) in England.

In September 2021, in a response to the consultation, the UK Government announced it would seek to bring forward primary legislation at a suitable opportunity to amend the regulatory definitions of a GMO to exclude organisms that have genetic changes that could have been achieved through traditional breeding or which could occur naturally. This will mean that some genome edited organisms will not be regulated in the same way as genetically modified organisms. The Government has indicated it will allow time to consider the distinctive ethical questions that arise in relation to animal welfare before changes affecting animal breeding are made.

Our report is intended to inform the development of a broad policy context that supports an ethical future for livestock and fish farming in the UK and beyond.



Challenges facing our food and farming systems

See Chapter 2 of the full report

The global food and farming system faces complex challenges which we have grouped under five main headings. The implementation of new biotechnologies, such as genome editing, in the global food and farming system may represent a means to address these challenges but also, potentially, to worsen them.

1. Animal health and welfare challenges

Animal welfare is a wider concept than animal health. It includes not just the physiological condition of the animal but the full range of experiences that constitute a good life. Various aspects of husbandry will affect animals' welfare, such as their living conditions, how much space and exercise they have, what they are fed and how often, access to veterinary care, their ability to form social bonds with others of the same species, and the physical and psychological effects of common farming interventions such as de-horning, tail docking and castration.

Breeding systems that have focused on developing productivity traits in the past (e.g. increased carcass size and litter size) have had many negative effects on animal health and welfare. For example, genetic selection for high egg production in laying hens has been shown to cause osteoporosis and put hens at increased risk of bone fractures.

As information and understanding of the effects of different farming and breeding systems have increased, there have been some improvements in some aspects of the conditions in which animals are kept, and some progress towards environmental objectives in breeding programmes. However, standards vary across the world, and many aspects of animal health and welfare continue to present challenges to the food and farming system.

2. Human health challenges

There are several risks to human health associated with farming and the consumption of animal products, including:

- **Increased risk of non-infectious diseases that can be linked to diet**, such as certain cancers, heart disease and type-2 diabetes.
- **Infectious diseases** that are naturally transmitted between animals and humans. The scale of their effect was demonstrated by the COVID-19 pandemic, caused by the SARS-CoV-2 coronavirus which first emerged in animals before transferring to humans. Livestock may be a significant transmission link between wild animals and humans as well as an incubator of new disease variants.
- **Antimicrobial resistance (AMR)** results from changes in bacteria, fungi, viruses, and parasites following exposure to antimicrobial drugs. Indiscriminate use of veterinary antibiotics has been linked to increasing levels of AMR. AMR represents a major threat to both human and animal health, mainly as a result of reducing the range and effectiveness of medicines available to treat infections.

3. Challenges of demand and supply

Demand for animal products is increasing, not only because we have more people to feed as our global population rises, but also because worldwide, people are eating more meat. The supply is precarious though, particularly in areas where people are vulnerable to disruption e.g. as a result of political, economic or climate instability. Two of the most important factors affecting supply of livestock are climate change (e.g. low rainfall and rising temperatures) and outbreaks of animal disease.

International trade is essential for most countries to secure a reliable supply of a variety of foods. The UK, for example, is not self-sufficient. It is a net importer of beef, poultry, pork and lamb. Reliance on international trade exposes a national food system to risks: the fluctuation in global markets can affect food supplies and price stability. The food supply, both in terms of the livelihoods of farmers and the choice of food available to consumers, is highly influenced by major food retailers. Livestock and fish farming are major components of the global food supply, but are

increasingly being challenged because of their contribution to environmental damage (see below).

4. Social, cultural and political challenges

What people eat depends on a variety of factors including social, cultural, religious, moral, political, environmental and economic factors.

There are differences in consumer trends of meat consumption between high- and low-income countries. In some high-income countries the amount of meat consumption is stable or falling, though vegetarianism is rare (less than 10% of the population) and veganism rarer still (though increasing). Worldwide, however, and especially in low-income countries, meat consumption is rising, associated with increased income, urbanisation and population growth.

If more countries start to follow this trend, the challenge will be to avoid the negative impacts (e.g. for public health, communities and the welfare of farmed animals) that accompanied historical rises in meat consumption in industrialising countries.

5. Environmental and ecological challenge

This set of challenges includes:

- **Greenhouse gas emissions** – methane emissions from cattle, nitrous oxide from animal waste, and carbon dioxide from the production of animal feed are some of the largest direct contributors to greenhouse gas emissions in the livestock sector. Emissions are expected to rise over the coming decades due to an increase in demand for meat and milk unless significant steps are taken to reduce them.
- **Waste and pollution** – the management of livestock waste presents a disease and pollution risk. Its management, processing, recycling and disposal are therefore important challenges for farming systems. The negative effects of waste are

likely to be worst in low-income economies where environmental regulations and large-scale water treatment may be limited.

- **Water scarcity** – on average, agriculture uses 70 per cent of the world's freshwater supplies, with about 20 per cent of that used for livestock. A small amount of this is drinking water for animals, while most is consumed indirectly in feed production, as well as in processing, washing, cooling and waste management. In some regions such as Asia and North Africa, the irrigation of crops used to feed animals puts significant pressure on the water supply.
- **Deforestation** – an estimated 73 per cent of forest loss in tropical and subtropical regions is due to the conversion of forest to agricultural land, much of which is used to support livestock. A key driver of deforestation in South America is for the production of soybeans for animal feed consumed mainly by pigs and poultry. Deforestation is linked to a rise in zoonotic diseases (diseases that transmit from animals to humans).
- **Biodiversity** – land used for grazing and feed crops in livestock production is perhaps the largest single factor accounting for biodiversity loss. Overgrazing has had a mainly negative effect on wildlife – e.g. through trampling and removal of vegetation, damage to root systems, and displacement of wild animals.

CONCLUSIONS IN BRIEF

The way in which the global food and farming system is organised and run makes it morally indefensible and unsustainable in its present form.

The ways in which we produce and consume food will have to adapt in order to provide a secure and sustainable supply of nutritious food for our growing global population.

Justice in food and farming systems

See Chapter 3 of the full report

Our report examines the values and considerations that should inform how food and farming systems can develop to address some of the challenges outlined in Chapter 2.

Justice within food and farming systems means arranging and managing those systems so that they secure the basic interests of those who depend on them. Securing these basic interests is a condition for anyone to be able to live a good life. As for humans, animals have certain basic interests that should be secured for them to live good lives, and for which they are dependent on the farming systems in which they are raised and kept.

For example:

- Access to safe, affordable and nutritious food is a basic interest of all members of society. Many people depend on farmed animals to meet their basic needs including people who are unable to access sufficient



protein or nutrients through plants and who are therefore dependent on meat, fish and dairy. Many are also currently employed in the livestock farming sector and rely on it for their livelihood.

- The lives of farmed animals depend almost entirely on the farming systems in which they live, which have been put in place by humans to serve human needs. Animals have basic interests that must be respected for them to have the possibility of living a good life within these farming systems. The things that animals need to meet their basic interests will vary from animal to animal and from species to species. They include fundamental conditions such as the absence of pain and suffering, but also more complex considerations involving emotions, behaviour and intelligence. This requires providing opportunities for farmed animals to have positive experiences, rather than simply removing factors that have a negative impact on their wellbeing.

CONCLUSIONS IN BRIEF

To ensure justice within our food and farming systems, the production and supply of food must be achieved in ways that secure the basic interests of people and of animals.

The introduction of any new technologies or innovations into the food system should aim to secure and promote these basic interests.

New breeding technologies

See Chapter 4 of the full report

Various applications of genome editing have been proposed in a number of domesticated animals and for a range of purposes. Examples of potential applications and areas of current research include:

Disease resistance

Diseases in farmed animals can be devastating in several ways – in addition to negative impacts on animal health and welfare, they can cause catastrophic economic losses for farmers, and be harmful for human health and wellbeing, ecosystems, and the environment.

Researchers have identified some specific sequences of DNA involved in disease resistance to some infectious diseases in animals. They can use this knowledge to design genome editing strategies that alter features of an animal's physiology to make it hard for the animal to become infected with the disease.

For example, it has proved possible to make pigs that are resistant to Porcine Reproductive and Respiratory Syndrome (PRRS) – one of the most significant pig diseases in the world. This is done by knocking out a specific gene that codes for proteins involved in a receptor that allows PRRS virus to enter a pig's cells, and cause disease.

Research has also shown the possibility of targeting a gene in cows to cause them to produce a protein in their milk that can kill the bacteria that cause mastitis, which is a prevalent infection in cattle.

However, there is a concern that genome editing for disease resistance may perpetuate, or even increase, the dense stocking of animals in industrial systems.

Alternatives to surgical intervention

Genome editing techniques are being developed to create a range of physiological changes that could replace common interventions in farming, such as horn removal, tail docking and castration.

The practice of preventing horn growth or removing horns to minimise harm to other animals and farm workers is common in livestock farming. However, many people are opposed to manual processes of dehorning, as they are painful to animals and cause them acute stress. Amongst the most advanced areas of research into genome editing applications is the production of polled (hornless) cattle. The known genetic variants associated with hornlessness do not appear to have any other adverse effects on health or productivity. Genome editing offers a promising strategy to breed hornless animals and skip the decades that may be needed to achieve this same outcome by traditional selective breeding, without the loss of other valued characteristics.

Environmental tolerance

A number of so-called 'functional traits' that are relevant to the specific living and environmental conditions that farmed animals live in have been targeted in breeding programmes.

For example, genome editing may provide opportunities to breed chickens with stronger bones in their legs, leading to improved mobility and fewer complications from being sedentary for long periods, or to breed farm animals with improved heat tolerance.

More than half the cattle in the world live in hot and humid environments. High temperatures can reduce their fertility and milk yield, and have a negative impact on animal welfare. Some breeding programmes in South America and Sub-Saharan Africa aim to ensure adaptation to tropical heat combined with high milk yield. An application of genome editing that has been explored is to achieve this by producing animals with lighter coloured hides, which allows them to reflect more heat and has a measurable impact on their productivity.

Production traits

Breeding for production traits is aimed towards directly increasing the value of animal products e.g. through faster maturation and increasing yield. From the evidence the working group has seen, most applications of genome editing technologies in farmed animals currently being researched are not aimed primarily at productivity gains, but this remains a possibility.

One area where technologies to improve reproduction and growth rates are being researched is in the farming of salmon. Genetic technologies have already been used to insert a DNA sequence into an Atlantic salmon from another fish, resulting in a faster growing variety that became the first genetically modified animal in the world to have been approved (in the United States) for human consumption. Researchers are exploring the possibility of achieving similar results using genome editing techniques.

Another example of the potential of genome editing is in laying chickens. Male chicks are routinely disposed of immediately after hatching since they cannot lay eggs and are of no economic value. Genome editing has been proposed as a way of adding a biological marker to allow male embryos to be identified in the egg so that they may be disposed of at the embryo stage (immediately after laying) rather than as hatchlings, thus saving incubator space and avoiding 50% of the chicken population being disposed of at birth.

CONCLUSIONS IN BRIEF

Genome editing has a range of potential applications in the breeding of farmed animals. In some cases, it is possible to see that genome editing might promote justice within our existing food and farming system, or help to address some of the challenges we have identified. However, there is also potential for genome editing to be put to uses that do not respect animals' basic interests.

We are particularly concerned about applications that might result in:

1. Breeding to produce animals that can tolerate poor conditions better without apparent adverse health impacts, thereby masking the fact that they continue to live in unacceptable conditions.
2. Breeding that results, over generations, in animals that have lost the physiological capacity to enjoy experiences that constitute a good life. (An example of this is the musculoskeletal problems that have resulted from historical pursuit of production traits in fast growing broiler chickens.)

Consumers and citizens

See Chapter 5 of the full report

Most supermarkets and retailers in the UK now offer a wide choice of meat and animal produce – ranging from 'high-welfare' produce such as RSPCA Assured chickens and organic meat, to cheaper, sometimes processed, forms of meat and dairy produce. While people often state a preference for high welfare products when asked, in practice consumers may be attracted by lower-priced food, or it may be the only choice available.

Value chains and power dynamics in the food system

From the farm to the marketplace, there is a 'value chain' where each stage of the food production process – e.g. processing, packaging, delivery – adds to the retail cost. For example, the average price of milk 'at the farm gate' in the UK in April 2021 was roughly 30 pence per litre. The average

price of a litre of milk in a UK supermarket was roughly 85 pence. This is a relatively short value chain involving farmers, milk processors, wholesalers and retailers. Other types of foods have much longer chains.

Major retailers hold a great deal of power within the food system. The main factor driving the choice of products available to consumers is the potential for retailers to expand their share of the market. Whilst consumers can choose from a variety of foods on the supermarket shelves, as individuals they generally have little influence on the range of foods that are offered for sale, except perhaps as part of nationally coordinated campaigns.

Public perceptions and attitudes are, nonetheless, likely to be significant factors in influencing how far genome editing technologies lead to novel foods appearing in shops.

PUBLIC ATTITUDES TO GENOMIC TECHNOLOGIES AND NOVEL FOODS

We commissioned an independent review of research into public perceptions and attitudes to the use of biotechnologies in agriculture and novel foods. The review offers four main conclusions:

1. Public attitudes depend upon how members of the public frame the innovations (e.g. whether as technological fixes, novel foods, or farming practices).
2. The reasons for, and intentions of, the applications are more important than the technical differences in the methods used.
3. The perceived benefits (rather than risks) are likely to be a critical factor in acceptance of specific applications.
4. The issue of 'naturalness' and people's concern for the environment are also likely to be important.



PUBLIC DELIBERATION ON GENOME EDITING AND FARMED ANIMALS

To help us to understand better what kinds of values and considerations informed people's response to genome editing as a prospective breeding technology, we commissioned a rapid online dialogue during June and July 2021. As the discussion broadened out, it became clear that, regardless of the breeding system used, participants were concerned about animal welfare standards in current intensive farming systems.

Generally, participants welcomed the possibility that genome editing could improve the health and welfare of farmed animals, e.g. through improved resistance to disease. They recognised positive reasons for using genome editing, such as securing equitable access to food, improving the quality of animal products, and reducing their environmental impact – as long as these were compatible with promoting higher standards of animal welfare, and the technology was carefully regulated.

However, participants in our dialogue were wary of the potential of genome editing to exacerbate what they saw as undesirable trends of intensification in farmed animal production. For this reason, they viewed the presentation of genome editing technologies as a way of accelerating conventional breeding practices as a reason for concern, rather than reassurance. In particular, they were opposed to genome editing being used when it was only to promote the interest of producers.

As the dialogue progressed, a central question emerged:

“ Will applying this technology take us closer to, or further away, from the agricultural systems we should aim for in the future? ”



Aspirations for the UK's future food system

Whilst the use of genome editing technologies in farmed animals offers the potential to help address some of the societal challenges we face with our current food and farming systems, it is important to note that many of its proposed applications aim to respond to challenges that have been caused by humans and/or to satisfy human wants. Ethical appraisal should take into account not only how well the intended results of a particular application of a technology meet moral standards and promote justice, but also whether there might be feasible, and ethically preferable, alternative ways to address the problems it is trying to tackle.

There may be cases in which altering the biology of an animal is a reasonable thing to do in order to meet human needs, but in other cases, alternative action may be preferable. Within an overall strategy which aims to secure a more just and sustainable future of the food and farming system, alternatives to the use of genome editing technologies in farmed animals could include the following:

- Encouraging and promoting incremental dietary change at national levels to consume less meat overall (e.g. as set out in the UK National Food Strategy)
- Reducing waste in the food system (e.g. more recycling, using more renewable energy sources, improving sanitation, reducing water wastage)
- Developing novel foods such as cultured meat and plant-based alternatives to meat and protein

CONCLUSIONS IN BRIEF

The emergence of genome editing provides an opportunity to align public policy with public interests and aspirations for the next generation of biotechnologies in food and farming.

To inform the development of policy, law and regulation in this area, more initiatives are needed to explore public views about how new breeding technologies might find a place in the future of the food and farming system. The focus of governance should not be limited to questions of the safety or direct harms to human or animal health arising from applications of the techniques. It must address how the uses to which new technologies are put can be regulated to secure a just and sustainable food and farming system.

Governance, principles and recommendations

See Chapters 6 and 7 of the full report

There are some gaps in the regulation of animal breeding in the UK. The breeding of animals in scientific research is regulated, as is the welfare of animals on farms. However, there is no regulatory framework, independent oversight, or national coordination of animal breeding companies and institutions, and there are gaps in the availability of information that is available about breeding practices and outcomes.

A lack of available and coordinated information in relation to the breeding of farmed animals makes it very difficult to assess important issues such as:

- The extent to which different breeding aims are actively being pursued.
- How successfully those aims have been achieved.
- The methods that are being used to achieve these aims.

The use of breeding indices, which aim to measure how the offspring of an animal are likely to diverge from what is considered normal for the breed, could be used to align breeding goals more closely with outcomes in the public interest.

UK GOVERNMENT PROPOSALS FOR THE REGULATION OF GENETIC TECHNOLOGIES

In early 2021 the UK Government launched a consultation setting out plans to reform existing regulations that govern the use of genetically modified organisms (GMOs) in England.

In September 2021, in a response to the consultation, the UK Government announced it would seek to bring forward primary legislation at a suitable opportunity to amend the regulatory definitions of a GMO to exclude organisms that have genetic changes that could have been achieved through traditional breeding or which could occur naturally. This will mean that some genome edited organisms will not be regulated in the same way as genetically modified organisms. The Government has indicated it will allow time to consider the distinctive ethical questions that arise in relation to animal welfare before changes affecting animal breeding are made.

CONCLUSIONS IN BRIEF

In order to achieve a just and sustainable food and farming system we need a coherent and concerted policy context that aligns all aspects with the public good. This should take account not only of the predicted costs and benefits of breeding innovations but also the implications of their use for animal health and welfare, for the food and farming system, and for wider society.

Guiding principles

In our report we set out five principles which are proposed as a framework within which evolving policy and governance may take shape.

1. Food security

Food and farming systems should be organised and managed in ways that deliver safe, nutritious food to meet the needs of all humans and animals who depend on them, now and for future generations.

2. Basic justice

Food and farming systems should be organised and governed in a way that respects the basic interests of the people and animals they affect i.e. giving them opportunity to live their lives in a state of safety, security and wellbeing, with access to the experiences that constitute a good life for them.

3. Proportionality and caution

Policy and governance for farmed animal breeding must look beyond just the predicted costs and benefits of innovations, to the implications of their adoption, diffusion and normalisation for the food and farming system. Policies must be aligned with addressing societal challenges such as food sustainability, animal welfare and environmental problems. The implications of not innovating, or of following alternative courses of action, must also be considered.

4. Engagement and procedural justice

New breeding technologies are likely to be the subject of strong public interest, especially where they could have a significant bearing on food security and/or affect the basic interests of people and animals. Those responsible for policy and governance should take steps to listen to the values and interests expressed by members of the public and act on them.

5. Cooperation and solidarity

Government and public authorities operating within the food and farming system should work with other countries to address international challenges such as food security and nutrition, animal welfare, animal health, animal-to-human disease transmission, biodiversity loss, ecosystem impacts and climate change.

Recommendations

The aim of our recommendations is to ensure that the potential applications of new breeding technologies help to address and not aggravate the societal challenges relating to our food and farming system. The introduction of new technologies into food and farming must be aligned with public and animal interests as part of an overall vision for a food and farming system of the future that supports, promotes and rewards sustainable farming and improved standards of animal health and welfare.

We make recommendations to the UK Government, animal breeders and developers, major food retailers and others involved in shaping the food and farming industries both in the UK and internationally.

Regulatory policy review

Any revision of the current regulatory regime for genetically modified organisms should be preceded by a thoroughgoing policy review that addresses the effects of any proposed change on the food and farming industry.

Public dialogue

The development of policy, law and regulation in relation to farmed animal breeding and the introduction of new breeding technologies, should be informed by public views.

Responsible breeding standards

All commercial breeders of farmed animals should adopt an explicit and recognised set of breeding standards, with independent oversight. In particular, these should seek to ensure that animals are not bred to enhance traits merely so that they may better endure conditions of poor welfare, or in ways that reduce their capacity to enjoy life.

Incentives for responsible breeding

Ways to encourage responsible breeding and the use of responsibly bred animals should be explored, for example through incentive payments to farmers associated with the use of animals with desirable characteristics.



Full value breeding indices

The use of breeding indices that reflect characteristics of animals that are of public or social as well as economic value should be explored as a possible regulatory measure. Commercial breed developers placing animals or animal reproductive materials on the market could be required to publish these indices.

Anticipatory governance of breeding

We propose a ‘traffic light’ system to assess the impact of breeding programmes on the lives of animals. Animals assessed to be in the ‘red’ category – where targeted breeding programmes have led to the production of animals with physiological traits that make it difficult for them to enjoy a good life – should not be used in commercial farming. This category might include, for example, fast-growing lines of broiler chicken. However, we envisage this approach working in an anticipatory way, to sound a warning when breeding is overreaching and to steer it towards more desirable outcomes. This system would apply to commercial breed developers and would need to be overseen by an independent authority.

We also recommend that an independent body should monitor the longitudinal development of breeding lines and report on these matters to the public authorities responsible for the oversight of farmed animal breeding.

Standard setting, monitoring, reporting, assessing

Public funding should be made available for independent research to develop, validate and integrate new measures and standards for on-farm welfare.

Public funding should be provided to develop integrated systems to monitor, record and report conformity with these standards, and to support their wide diffusion and adoption on farms.

Food labelling

Labelling of foods containing animal products should include scientific advice on food safety, nutrition and health and provide access to traceable attributes of interest to consumers, which may include factors such as:

- breeding practices and technologies used
- the animal’s living conditions and diet
- region of origin
- the ways in which products are processed

Retail concordat

The UK Government should bring the major food retailers together to agree a pathway to ensuring that only products that come from animals that have been responsibly bred are offered for sale. The agreement should include a plan of how this will be achieved and overseen, including how it may be backed up by retailer (rather than product) accreditation.

Diet change

Public support, including funding, should be provided for initiatives to develop new food sources, make more just and effective use of existing ones, and to encourage and support voluntary changes in the people’s diet towards consuming animal products at sustainable levels and only when these are responsibly bred.

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www.nuffieldbioethics.org

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