The modification of Little Chick

by Karin Mont

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One Christmas Eve, about 20 years ago, a friend turned up unexpectedly clasping a small cardboard box. It did not contain a last-minute Christmas gift, but a somewhat bewildered-looking day-old chick, which my friend hoped we could rescue. The chick had been found by the roadside, and we assumed it must have escaped off a lorry heading for the nearby broiler unit. The first priority was to ensure that the chick was warm and safe. The next priority was to persuade the chick to eat and drink. This can be a challenge for a young chick, already weakened by hypothermia. We needn't have worried; from the very first time we placed food in front of it, this chick tucked in. In fact, it ate, and ate, and ate!

We called this compulsive, obsessive and unstoppable food-consumer Little Chick, and it soon became clear that eating (and occasionally drinking) was Little Chick's one and only interest in life. It grew at an alarming rate, and was quickly identifiable as female. She did not enjoy moving around more than was absolutely necessary and, by the time Little Chick was eight weeks old, she was struggling to walk – her legs were not strong enough to support her excessive weight.

Because of her increasing immobility, we had that difficult and painful discussion about 'doing the deed' sooner rather than later. We knew that letting her carry on would lead to an inevitably fatal outcome but, unsurprisingly, no-one had the heart to dispatch Little Chick. She died, presumably of a heart attack, in April, aged about four months, and she weighed in at nearly two kilos. I think she had been happy in her very limited way, and I'm glad we were able to offer her a glimpse of normality in her short life, but she was certainly not bred to be normal. She was the unfortunate product of modification using traditional breeding methods, a topic which has recently been under discussion via an under-publicised consultation entitled 'The regulation of genetic technologies'.

The background behind this consultation, which ran from 7 January to 17 March 2021, is as follows: Currently, section 106, subsection 4A, of the Environmental Protection Act 1990, describes a genetically modified organism (GMO) as one where 'genes or other genetic material' have been 'artificially modified' by using a process other than that 'which occurs naturally in mating, or natural recombination'. Genetic technologies have advanced considerably since the 1990s, and gene editing, where DNA is added, removed, altered or replaced within the genome of a living organism, is a commonplace activity within the laboratory setting. Organisms modified by gene editing are classified as GMOs, and fall within a strict regulatory framework, but the Department for Environment, Food and Rural Affairs (Defra) is trying change that. It wants gene edited organisms, which previously would have been developed using traditional breeding methods, reclassified, and subject to less stringent legislation than GMOs. Obviously, defining and determining what constitutes natural breeding within the context of a laboratory setting where gene editing is applied, is a matter for considerable debate. However, Defra suggests that gene editing which mimics the 'natural' way, is fundamentally a straightforward process that just requires more focused research to perfect.

Defra states the main difference between GMOs and gene edited organisms as being that a GMO contains the DNA of more than one species, whereas a gene edited organism usually just has its own DNA, which is modified, without introducing DNA from another species. This, according to Defra, is exactly what happens with traditional breeding, only the natural method works at a much slower rate. Changing existing legislation, so that gene editing research can be fast-tracked without the constraints of the current regulatory framework, is presented as a great benefit by Defra. For example, they claim that farming will become more efficient and productive, because gene editing can remove the faults and introduce the desirable traits in livestock, plants and crops, making them all stronger, healthier and more disease resistant. By 'unleashing' these new technologies, we can also help the developing world produce the food they need, whilst minimising the impact this increased productivity might have on climate change. Defra even claims that gene edited crops produce fruit and vegetables which are healthier to eat – gene edited tomatoes which help to lower blood pressure, is given as an example of the health benefits of this developing technology.

In their introduction to the consultation, Defra acknowledged that there was a broad spectrum of opinions on the matter of separating out gene editing from GMO legislation, and claimed that they wanted to hear all views, but the consultation questions were clearly intended primarily for geneticists and research scientists. With questions that were far from easy for an ordinary member of the public to address, and answers requiring supportive evidence, one could be forgiven for thinking that Defra was trying to slip this consultation through, without too many people noticing.

So, can (as Defra claims) gene edited organisms really be the same as those created using traditional breeding methods? Probably not, for a number of reasons. Disasters happen with traditional breeding. These quickly become apparent, and 'faulty' stock can be culled or destroyed before the negative genes / gene mix are no longer controllable. Little Chick, despite being an aberration of what we would normally expect to see in a healthy chicken, was actually a good example of successful genetic modification, using traditional methods. The traits and characteristics which turned her into an efficient food consuming, food producing machine, were developed over a period of time, by a process of trial and error. Although Little Chick could only live a very limited life-span in a managed and totally artificial

environment, that was what she was bred to do, and her modified (from normal) genes, were not transmittable to other species.

Genome edits conducted in the lab are a different matter, and bear little resemblance to traditional breeding. **Crucially, the medium and long-term consequences of this novel technology are completely unknown.** Just because we now know how to apply a gene edit in order to alter the genome of a living organism, doesn't mean we should do it. Given that our understanding of the function of genomes in general is highly limited, it seems both irresponsible and dangerous to engage in altering the basic building blocks of life, armed only with partial knowledge. In fact, the suggestion that genetically edited organisms are the same as those which exist through traditional breeding is entirely hypothetical anyway, and that needs to be stated. It also raises the question, if gene editing and traditional breeding really are one and the same thing, why would anyone choose to take the risk of genetically modifying anything?

Perhaps the answer has something to do with the rising influence and power of the biotech industry. The genetic modification of crops is potentially the most worrying example of human gene experimentation, on the basis that irreversible damage to the whole ecosystem may only become apparent after the passing of time, when it is too late to control the spread of rogue genes. An alarming loss of biodiversity has already been observed in regions where GM crops are permitted, and because global GM seed production is delivered by powerful biotech companies, we are in danger of becoming totally dependent upon large, profit-driven corporations, for the most basic food-supplies.

The Defra view of the benefits of gene editing is idealised, and fails to point out any negative aspects. For example, using gene editing to develop a particular trait, such as yield improvement in a crop, doesn't just involve a single process, but a series of processes. The risk of introducing unintended, or even harmful traits increases with every gene edit. **In fact, unintended genetic changes are common with gene editing, and this is a matter of major concern to researchers**. New gene-editing technologies give researchers access to parts of the genome normally protected against mutations, which means that when an edit goes wrong, it can negatively impact upon a different, even vital, function.

Gene editing is definitely not a simple process, and unintended consequences pose a significant risk to all living organisms. True, gene editing technology now makes it relatively easy to make very precise, well-targeted 'cuts' into the DNA of an organism. However, when the edited cell initiates its own repair process, things can go wrong, and genetic errors can (and do) occur. This can happen even when just a single gene is targeted, which means that when multiple genes are targeted, the likelihood of multiple errors occurring, increases significantly.

There are other problems to consider, such as the process of transgenesis, where a gene from one organism is introduced into the genome of another, which may be a different species altogether. Gene editing is not supposed to involve the use of transgenes, but we know transgenesis can happen by accident. For example, bovine and goat DNA has been found in gene edited laboratory mice, because the culture medium used to grow the mouse cells contained body fluids extracted from cattle and goats.

It is obvious that transgenesis could represent a very serious risk to our environment, so it seems increasingly disingenuous to compare gene editing techniques to traditional breeding. Furthermore, we have no idea what the direct risks to human health might be, from eating gene-edited animals, or their produce, because no studies have yet taken place. What we do know is that gene-edited production animals on factory farms have developed antibiotic resistant genes, and this has significantly impacted upon the overall use of antibiotics in the food chain, which in turn has raised levels of antimicrobial resistance (AMR) in humans.

In addition to the hypothetical food production benefits listed above, Defra suggests that separating out gene editing from GMO regulation will also provide researchers with the opportunity to develop new 'precision' medicines, to be used to treat humans. That has already happened, and we are currently witnessing the progress of the largest experimental medical trial on humans ever undertaken. The trial involves a new generation of genetic vaccines which, in this instance, have been modified to generate an immune response to SARS-CoV-2 (Covid-19) in the vaccinated individual. Basically, the vaccines are composed of synthetic DNA or RNA, encapsulated by a membrane which enters the human cell via a process called transfection. This is a similar process to the manner in which a wild virus enters the host cell naturally. Once in the host cells, the synthetic DNA or RNA instructs the cells to create the coronavirus spike protein – this is the part of the virus which triggers an immune response, and the subsequent formation of antibodies.

Described in simplistic terms, these genetic vaccines hijack the cell, and turn it into a virus-creating factory. It is the equivalent of tricking our own genome, which is normally programmed to protect us, into creating an enemy invader which then has to be eliminated. In reality, the processes involved are highly complex, and we have no idea what the long-term consequences of gene edited vaccines, or indeed any other form of gene therapy, might be.

What seems abundantly clear is that any attempt by Defra to relax current legislation relating to gene editing or GMOs, should be stringently opposed. DNA is the most fundamental building block of all life forms. It belongs to the natural world, and it is not the property of the pharmaceutical industry, or biotech. At the very least, we have to allow more time to fully evaluate the long term consequences of existing GMOs, before releasing new gene edited organisms into our delicately-balanced ecosystem. The modification of Little Chick using traditional breeding methods was less than perfect from her perspective, resulting in a travesty of a chicken, totally dependent on human intervention to support her through her brief and unnatural life. Her gene edited equivalent, could turn out to be even more dysfunctional.

Whether we like it or not, gene editing is here to stay. The Government must ensure that the future development of all genetically engineered / modified organisms, follows rigorous, process-based, regulatory protocols, with proper checks / balances in place that clarify how an organism is created. If this does not happen, we will have to be proactive in making it happen, by using a combination of lobbying MPs, and by applying consumer pressure to clearly demonstrate how we view GM products. We must succeed in achieving openness, honesty and transparency, in every aspect of genetic modification, because all life matters. □