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Biotech can help make our food healthier, safer and more sustainable

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Continued growth of the global aquaculture sector, allied to concerns over the sustainability of marine fish stocks traditionally used as feed, are driving increased interest in health-giving Omega-3 enriched oilseed crops as a renewable feedstock. Recent food scares over ‘forever chemicals’ found in eggs, linked to the use of fishmeal as feed, suggest biotech crops may not only be more sustainable, but also safer, writes Professor Johnathan Napier.

In March this year, Norway’s Food Safety Authority became the latest country to conclude that using Omega-3 enriched GM rapeseed oil in aquaculture feed poses no additional health or environmental risks.

It followed an application by biotech firm Nufarm for approval of Aquaterra, a rapeseed oil genetically modified to include genes from marine algae and engineered to make DHA, an Omega-3 normally only found in fish oils and not present in standard rapeseed oil.

Interestingly, this was the first application to use a genetically modified product in Norway.

Approvals for the use of the same Omega-3 enriched GM rapeseed oil in aquafeed have also been confirmed by food safety authorities in Australia, New Zealand, Canada, USA and Chile.

Indeed, Aquaterra is already in commercial use in Chilean aquaculture, the second largest producer of farmed salmon in the world.

There are also signs that other major fish farming regions of the world, including in Asia, are beginning to recognise the potential benefits of biotech crops as a more sustainable feed source for aquaculture.

Last month, for example, a conference in India organised by the Indian Government in association with the Central Marine Fisheries Research Institute (CMFRI) focused on precisely this issue. Expert speakers highlighted the enormous scope for GM crop-based products not only to enhance the supply of feed ingredients in aquaculture - promoting growth and reduction of input costs - but also to help mitigate the impact of mounting pressure on global supplies of fishmeal and fish oil.

Ensuring the sustainability of marine fish stocks is a critical issue, especially in a year such as this when the El Niño climate phenomenon is predicted to return, placing extra pressure on feedstocks. In particular, El Niño negatively impacts South American catches of species such as Anchoveta in the Pacific, which typically account for around 40% of global fishmeal and fish oil production. The most recent major El Niño event (2014-2016) [reportedly](#) reduced fishmeal and fish oil output in Peru and Chile by as much as a quarter.

In recent years, concerns over the sustainability of aquafeed have also impacted the healthy eating profile of farmed fish. A diet rich in omega-3s is health-protective, especially in reducing the risk of cardiovascular disease (CVD), and a key challenge for the salmon farming industry is to sustain the sector's growth while maintaining levels of the healthy omega-3 oils such as EPA and DHA in the final product.

Over a 10-year period, levels of these beneficial oils in farmed salmon have declined by 50%. This is primarily due to the measures taken to protect marine fish stocks, which mean that while the global salmon farming industry has grown by more than 50% over the past decade, the annual harvest of marine fish oils has remained static at around 800k tonnes, diluting the available fish oil across a bigger pool of production.

This in turn has encouraged a trend of replacing marine oils with vegetable oils, which lack the special health-giving omega-3s found in fish oils, and are changing the fatty acid profile of the salmon fillet the consumer is now presented with – they might now get a product that has less impact on the marine environment, but unfortunately it also less nutritious.

A healthier and more sustainable solution may lie in the application of crop biotechnologies such as GM and gene editing.

My own research has shown how oilseeds like *Camelina sativa* can be engineered to accumulate omega-3 fish oils such as EPA and DHA, providing a renewable, crop-based alternative to over-stretched marine resources.

Successful aquafeed trials in Scotland have already demonstrated how this could help make salmon farming more sustainable and more nutritious – breaking our dependence on the oceans as a source of fish oils while restoring omega-3 levels in farmed salmon to what they were 10 years ago.

It is a major source of personal frustration to me that UK-led innovation at Rothamsted Research, which has long been in the vanguard of these exciting developments, is still limited to tennis court-sized field trials, and its commercial uptake stymied by political opposition to genetic innovation, especially in Scotland.

The science is there. The use of innovative crop technologies is already benefiting aquaculture production in other parts of the world. It is ironic that the Aquaterra GM rapeseed oil was developed after our GM camelina, but has undergone swifter regulatory approval.

With vision and political will, these added-value crops could not only support the Scottish salmon farming industry's ambitious plans to double output from 170k tonnes to 350k tonnes by 2030, but also provide an alternative income stream for Scotland's farmers, directly connecting agriculture and aquaculture at the national level rather than importing feed ingredients from the other side of the planet, one aspect of the industry's 'green' credentials that is often overlooked.

But there is another pressing reason why it makes sense to cultivate the use of biotech crops as a source of Omega-3 oils.

Safer food.

A recent [study](#) by Denmark's DTU National Food Institute reported very high levels of marine-derived persistent environmental pollutants, or PFAS, in organic eggs. So high, in fact, that the authors warned that children aged 4–9 consuming more than 2.5 organic eggs per week may be ingesting unsafe levels of these 'forever chemicals'.

The study also linked the PFAS found in the eggs to the use of fishmeal, which is routinely fed to laying hens. The authors described how these harmful, persistent chemicals can work their way up the food chain, from fish to hens to humans, accumulating in organic tissue at increasingly higher levels at each stage.

The study's recommendation? Switch to an alternative, non-contaminated feed source.

Ideological opponents of biotechnology in food and agriculture often contend that these technologies are solutions looking for problems to solve. But with continued growth of the global aquaculture sector, and the ongoing challenges associated with marine feedstocks, the potential opportunities to provide a renewable, plant-based source of healthy Omega-3 oils are undeniable, delivering benefits in terms of sustainability, healthy-eating, economic growth and food safety.

What's not to like?

Professor Johnathan Napier is a leading pioneer in plant biotechnology and an advocate for the power of GM plants to deliver for the public good. At Rothamsted Research, his flagship research programme involves both GM and gene editing techniques to develop oilseed crops with enhanced Omega-3 levels as a more sustainable, plant-based source of healthy oils for human nutrition and for the aquaculture sector. He is a member of the Science for Sustainable Agriculture advisory group.