GM Team
Department for Environment, Food and Rural Affairs
Second Floor
Seacole Building, Marsham Street
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Submitted by email to gm-regulation@defra.gov.uk

12 April 2023

Dear Madam/Sir

Re: Application from Rothamsted Research to release a genetically modified organism, reference 23/R08/01 as published at https://www.gov.uk/government/publications/genetically-modified-organisms-rothamsted-research-23r0801.

We are writing on behalf of GM Freeze, GMWatch, Beyond GM, EcoNexus, The Soil Association, The Landworker's Alliance, the Biodynamic Association, The Kindling Trust, Green Christian, Hodmedod's, Veg Box People, Shepton Farms, GM Free Cymru, Agri Activism UK, GM Free Dorset, GM Free Somerset, Avon Organic Group, Banc Hadau Llambed/ Lampeter Seed Library and SE Essex Organic Gardeners to request that the above application to release genetically modified (GM) Camelina is refused.

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GM Freeze is the UK umbrella campaign for a responsible, fair and sustainable food system, focused on concerns about the use of genetic engineering in food and farming.

GMWatch provides the public with critical information and comment on genetically modified foods and crops and associated pesticides. **Beyond GM** is an initiative educating and engaging the public to raise the level of debate around the issues of GMOs and sustainable food production in the UK. **EcoNexus** analyses and reports on new technologies that have the potential for significant negative impacts on biodiversity and ecosystems.

The Soil Association is the charity that digs deeper to transform the way we eat, farm and care for the natural environment. **The Landworkers' Alliance** is a grassroots union representing farmers, growers and land-based workers. **The Biodynamic Association** promotes biodynamic methods for healthy farming, forestry and gardening for planet, nature and people. **The Kindling Trust** works with communities, farmers, health providers, activists and policymakers to create a fairer, more sustainable food system for all. **Green Christian** are inspired by their faith and work to care for Creation through prayer, living simply, public witness, campaigning and mutual encouragement.

Hodmedod's works with British farmers to offer a range of foods from diverse arable crops to retail, catering and manufacturing customers. **Veg Box People** supports local organic growers to make organic produce accessible to those living in urban areas. **Shepton Farms** are organic farmers and fruit growers.

GM Free Cymru is the community pressure group campaigning to keep Wales free of genetically modified crops. **Agri Activism UK** is a network of people who campaign for cleaner, healthier and more sustainable agricultural and food systems. **GM Free Dorset** is a grass roots campaign promoting rural sustainability across the county of Dorset. **GM Free Somerset** is a grass roots campaign supported by individuals, groups, local businesses and charities that exist to promote rural sustainability.

Avon Organic Group promote organic growing to their members and the local area by organising talks on all aspects of organic gardening. **Banc Hadau Llambed/ Lampeter Seed Library** aims to build local food and seed security through increasing and sharing stocks of locally adapted open-pollinated food seed as a free community resource. **SE Essex Organic Gardeners** is a local group of Garden Organic, supporting and working with the Soil Association and Pesticide Action Network UK.

We are of the strong opinion that the planned open field trial should not be allowed to go ahead. The application is incomplete, the intended genetic modifications may cause harm, containment cannot be guaranteed and the proposed trial raises significant ethical concerns. In summary, our objection covers the following points:

1. The application is incomplete

2. The intended genetic modifications may cause harm
   2.1. Terrestrial production of omega-3 long-chain polyunsaturated fatty acids is a risk to wildlife and the wider ecosystem
   2.2. Production of ultra-long polyunsaturated fatty acids introduces additional, potentially novel, risks
   2.3. Production of milk fats introduces further risks that have not been adequately considered
   2.4. The GM plants are likely to contain herbicide tolerance genes
   2.5. The GM plants are likely to contain antibiotic resistance genes

3. The scale and management of the planned trial raise significant concerns about escape and contamination
   3.1. The increased scale of the proposed trial intensifies a range of existing concerns
   3.2. Camelina is grown commercially in the UK, including close to one of the trial sites
   3.3. The proposed containment measures are inadequate

4. The proposed trial raises significant ethical concerns while offering no net benefit to society
   4.1. Human and other mammalian genes have been inserted into the GM camelina
   4.2. Cultivation of GM crops will not improve the sustainability of the aquaculture industry

1. THE APPLICATION IS INCOMPLETE

Paragraph 14 (Part A1) of the application pro-forma for consent to release a GM higher plant requires detailed information "on the sequences actually inserted or deleted". However, as with their previous application 19/R08/01, the applicant has instead stated their desire to plant "various combinations of biosynthetic activities… using a panel of genes from different organisms".

The table of genetic elements listed in Part A1, paragraph 12 includes over 130 different entries while paragraph 13 of the application lists six separate traits that will be introduced or modified. As we stated in our objection to application reference 19/R08/01[1]:

> *"This 'pick and mix' approach to field trials of GM crops clearly breaches the requirement for a precise description of each GM line to be trialled. It is not possible to carry out a meaningful risk assessment and the GM camelina trial should be rejected on the grounds that no information has been supplied on the specific GM lines to be trialled."*

We note the Advisory Committee on Releases to the Environment (ACRE)'s view expressed in its advice to the Secretary of State on trial application 19/R08/01[2] that such details are only required "on a case by case basis depending on whether it is necessary for the risk assessment". However, molecular characterisation is a regulatory requirement under the UK Genetically Modified Organisms (Deliberate Release) Regulations 2002 no. 2443. It is also essential to any meaningful risk assessment.

Without molecular characterisation for each GMO to be planted we have, for example, no evidence about the occurrence or impact of unplanned changes to the camelina's own DNA; no way of knowing whether sections of vector backbone have been integrated; no idea of whether or not the various constructs have been stably inherited. ACRE justified their advice to ignore these open questions around the 2019 trial on the basis that "material from the trials will not enter the human food chain or the animal feed chain and … these trials are small-scale". However, as we describe in 3.1, below, the proposed field trial is no longer small in scale and the containment measures described in the application are inadequate. We cannot be sure that the experimental plants will not enter the food chain or the wider environment so it is imperative that full details are made available of both what will actually be planted and how the risks associated with each line will be mitigated.

The final section in paragraph 13 of Part A1 of the application describes the use of the CRISPR-Cas9 gene editing tool to manipulate genes involved in fatty acid metabolism. This section goes on to note that "Gene-edited plants devoid of transgenes are not considered GMOs (instead classified as Qualifying Higher Plants or Precision Bred Organisms)." This is, of course, untrue as Qualifying Higher Plants (QHP) and Precision Bred Organisms (PBO) remain legally classified as GMOs despite being exempted from certain regulatory requirements. Regardless of this important technical detail, it is worrying to note that the applicant appears to be implying that some lines within the proposed field trial are not subject to GMO regulations. In paragraph 14 of Part A1, the application notes that "It is envisaged that some of the constructs described above could undergo CRISPR-Cas9 gene editing to inactivate (through sequence-specific deletion) endogenous genes." The "constructs described above" involve complex mixtures of transgene insertion so the resulting lines will remain under GMO regulations, regardless of the use of CRISPR-Cas9 mediated genome editing.

Indeed, the use of CRISPR/Cas9 genome editing systems is one of several reasons why long read whole genome sequencing is essential, but not sufficient, for a meaningful risk assessment. Genome editing techniques are associated with unintended effects including off-target activity leading to the mutation of non-target genes[3] and unintended genetic changes at the target site, such as complex DNA rearrangements, insertions and deletions[4]. In addition, gene "silencing" via interfering RNA (RNAi) suffers from intrinsic risks including the potential off-target silencing of other genes within the target organism, as well as unstable and variable silencing.[5]

We cannot know what has actually happened to the genome of the camelina plants without the use of long-read whole genome sequencing, but this should also be backed up by "omics" profiling to assess global RNA, protein and metabolite profiles in an unbiased manner. New research published in February of this year[6] concludes that "a science-based, risk-related approach based on omics techniques" offers "several advantages for the risk assessment procedure".

Finally (on this point), the applicant's risk assessment in Part A4 of the application states that no mitigation has been put in place for potential changes in biogeochemical processes resulting from unintended changes in the modified plants because such changes are "not expected". Without full molecular characterisation of the GM camelina lines that will actually be grown, this is little more than a guess.

The trial consent application should be rejected on the grounds that the application does not include any molecular characterisation of the GMOs to be planted. It is not possible to carry out a meaningful assessment of the risks that the proposed trial poses until such detail, ideally backed up unbiased omics analysis, has been supplied.

2. THE INTENDED GENETIC MODIFICATIONS MAY CAUSE HARM

2.1. Terrestrial production of omega-3 long chain polyunsaturated fatty acids is a risk to wildlife and the wider ecosystem

The proposed field trial is part of a long term research project focused on engineering camelina plants to biosynthesise long chain polyunsaturated fatty acids (LC-PUFA), particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

We have raised concerns about the ecological effects of introducing LC-PUFA to the terrestrial ecosystem in our responses to previous field trials[7] particularly noting research studies in 2016 and 2018 that linked these concerns with field trials of GM camelina engineered to produce EPA and DHA[8]. Indeed, we would like to reiterate our comments in response to the applicant's 2019 application, as follows:

> The GM camelina in this field trial represents a **novel** category of risk as the LC-PUFAs are bioactive molecules that are not normally present in terrestrial ecosystems (only aquatic)[9]. As MacDonald et al. (2018) [10] conclude: "*That problem lies in the fact that growing oilseed crops engineered to produce EPA and DHA means introducing to a terrestrial ecosystem a pair of highly bioactive nutrients that are, for the most part, foreign to terrestrial ecosystems at the level of primary producers and their herbivorous insect consumers.*"

Colombo et al (2018)[11] concluded that, although aquaculture and therefore human nutrition may benefit, "*the novel introduction of EPA and DHA, through GE oilseeds, has the potential to cause unintended, and potentially irreversible, ecological and evolutionary consequences in terrestrial agro-ecosystems. Introducing EPA and DHA into terrestrial ecosystems may alter the physiology and ecology of land-based insect populations (and their consumers), both those considered to be crop pests, as well as those that are considered to be beneficial insects. Once terrestrial crops begin producing EPA and DHA, transfer and hence retention of this unique capability within the terrestrial food web may be inevitable and irrevocable, leading to potential downstream effects that are, as yet, not understood.*"

The authors made three recommendations:

"First, to verify the efficiency of the seed promoter, assessments of the potential for EPA and DHA synthesis in other plant tissues (vegetative, flowers, nectar, and pollen) should be independently confirmed.

Second, the potential for gene flow of these transgenes among crops or from the crop to sexually compatible wild relatives and the fitness consequences of this gene flow should be assessed to determine the risk that these crop-derived genes will escape cultivation.

Third, experimental studies, where actual GE-plant tissues (in particular seeds, rather than artificial diets), are fed to different crop pest species (with different feeding habits) should be conducted in confined and controlled conditions."

In its advice on the applicant's 2019 application (19/R08/01), ACRE[12] "agreed that the introduction of such novel compounds into the terrestrial food web on a larger scale would need to be considered in detail" before concluding that scale and seed-specificity provided enough mitigation to allow that trial to go ahead. We discuss issues of scale in 3.1, below, but are alarmed to see that the applicant reports, in the risk assessment included in Part A4 of this application, that "The seed-specific expression of these transgenes has been confirmed for **at least one line** described in this application." [our emphasis] The proposed trial includes a vast array of genetic elements to be combined in potentially hundreds of different permutations and it is part of a research programme that has been ongoing for over a decade. It is simply unacceptable that they have not published any further details on which, if any, of the various introduced traits have been successfully limited such that they are only expressed in the camelina seeds.

In addition, we are concerned to see that the applicant appears unaware of a study published in November 2019[13] that concluded that "in terms of commercializing transgenic oilseed crops, the potential for introducing EPA and DHA in the agroecosystem may have broad consequences for the growth and survival of many terrestrial organisms". This new research found that two common North American insect pests – cabbage looper and bertha armyworm – retained dietary EPA and DHA and that insect biomass was altered by exposure to these oils. Although the insects involved in this study were once again fed EPA and DHA directly, both are generalist feeders which damage both foliage and seedpods of brassica crops. Indeed, at high infestation rates it is observed that whole oilseed pods can be consumed by bertha armyworm larvae.

It is unlikely that either cabbage looper or bertha armyworm will be exposed to the experimental camelina plants in this trial. However, significant effects have been observed in all three insect species that have been studied to date (cabbage whites in the 2016 study and cabbage looper and bertha armyworm both in 2019). It is, therefore, entirely reasonable to conclude that there is a high probability that other wildlife may be impacted by the introduction of LC-PUFAs into the terrestrial ecosystem, whether it is limited to the seeds of the GM camelina or not.

The proposed GM field trial should not be allowed to proceed until detailed research has been undertaken into the potential impacts of the trial on insects prevalent in the local area.

2.2. Production of ultra-long polyunsaturated fatty acids introduces additional, potentially novel, risks

In addition to the "fish oil" PUFAs described above, the applicant proposes growing GM camelina plants that will produce ultra-long PUFAs similar to those found in the retina, nervous and reproductive systems of a range of vertebrates. Very little information on these compounds is included in the application but promotional material published elsewhere by the applicant[14] suggests that these are intended for pharmaceutical use, particularly in the treatment of macular disease.

The production of pharmacologically active compounds through agricultural cultivation raises a wide range of concerns and experiments of this nature should be conducted in a contained environment such as a greenhouse. As we have seen above, the presence of compounds that are novel in a terrestrial environment can disrupt the ecosystem. The additional synthesis in the GM plants of ultra-long PUFAs will only compound this problem.

2.3. Production of milk fats introduces further risks that have not been adequately considered

Another new trait that the applicant is squeezing into the planned field trials, again with very little information included in the application, is the production of what it describes as "milk fats". The only explanation for their inclusion is that they have features which "contribute to the texture and taste of animal fats, as well as effecting how the fats are broken down and absorbed into the body".

It might be reasonable to assume that the bovine milk fat which it appears will be produced by some of the GM camelina plants is not entirely novel in the terrestrial ecosystem. However, it is not naturally produced in plants and will form a novel compound in the diet of any organism that feeds on the plants grown in the trial, or that grow elsewhere as a result of escape (see 3.3, below).

Allergies to cow's milk are common and can be life threatening. Although most people who need to avoid milk react to specific proteins or sugars, the novel presence of bovine compounds in plants raises concerns. The allergenicity of all parts of the GM camelina plants should be thoroughly tested before they are grown in open field trials.

In addition, the ethical implications of introducing a mammalian compound to plants in the human food chain need to be thoroughly explored, including with representatives of faith and consumer groups that may have deeply held beliefs on the subject. This issue is explored in more detail in 4.1, below.

2.4. The GM plants are likely to contain herbicide tolerance genes

Given the lack of information provided on what will actually be planted (see 1, above) we cannot be certain which traits will actually be present in the camelina plants grown in the proposed trial, but the application states that selectable markers have been used that confer tolerance to both glufosinate ammonium and bialaphos.

We note ACRE's view, expressed in response to numerous GM field trial applications, that the presence of herbicide tolerance marker genes is unlikely to confer a selectable advantage on any plants that escape a GM field trial. However, the containment measures for the proposed trial are not adequate to prevent escape (see 3.3, below) and the spread of a herbicide tolerance trait to wild or cultivated relatives could have a significant impact over time.

Similarly, in the event of commercialisation of crops based on this trial, farmers facing short-term pressures are likely to utilise the herbicide tolerance trait. This could have a significant effect on biodiversity by reducing plants available to wildlife, as shown in the UK Farmscale Evaluations for oilseed rape, in the same botanical family as camelina.[15] No GM crops with herbicide tolerance traits should be released into the environment, including through a field trial.

2.5. The GM plants are likely to contain antibiotic resistance genes

As with herbicide tolerance genes, above, we cannot be certain which traits will be present in the camelina plants grown in the trial, but the use of multiple antibiotic resistance genes as selectable markers is of significant concern. We highlight comments we have made in a number of previous submissions relating to proposed GM field trials, including in response to an application for consent to release experimental GM potatoes (22/R29/01) which also featured the nptII gene:[16]

> "Kanamycin is listed as an essential medicine for priority diseases by the United Nations World Health Organisation (WHO)[17] and concern about the future of therapeutic antibiotics is only growing among learned organisations such as the European Medicines Agency[18].
>
> "Globally, there is a high level of concern regarding the rise of antibiotic resistance that could render key antibiotics ineffective in treating infections in humans and animals. The UK government recently published a 20-year vision and 5-year national action plan[19] to prevent further antimicrobial resistance, which includes antibiotic resistance. The vision calls tackling antimicrobial resistance a "global priority", while the 5-year plan includes the reduction of antimicrobials in agriculture[20]. Therefore, any consent to cultivate GM plants that may contain antibiotic resistance genes, even as a field trial, is not in keeping with the UK national action plan to prevent further antimicrobial resistance."

3. THE SCALE AND MANAGEMENT OF THE PLANNED TRIAL RAISE SIGNIFICANT CONCERNS ABOUT ESCAPE AND CONTAMINATION

3.1. The increased scale of the proposed trial intensifies a range of existing concerns

The applicant has been growing experimental GM camelina plants in open field trials at its Harpenden site since 2014, and at its Brooms Barn site since 2018. In that time, the scale of the trials has increased dramatically, from 900m^2 in 2014 to – if approved - a total of 15,000m^2 under this new application. This can no longer be considered a small trial and, indeed, its significantly increased scale raises questions about just how extensive an area can be cultivated under the status of an experimental field trial.

The large scale of this trial – and the near decade of related trials that precede it – also raise concerns about the potential re-use of plots. As noted in 3.3, below, the applicant has repeatedly failed to reflect previous monitoring requirements in the containment protocols that it proposes in its applications for consent, perhaps suggesting a desire to more quickly clear plots for reuse.

The proposed field trial should not be allowed to proceed until further information is published on re-use of experimental plots. In addition, the significant scale of the proposed trial should be reflected in the consideration afforded to other concerns including the potential for escape and for ecosystem disruption.

3.2. Camelina is grown commercially in the UK, including close to one of the trial sites

The applicant notes, in Part A1, paragraph 7 of the application that "*C. sativa* is grown as a crop in Canada and the USA" but fails to mention that camelina has been grown in England for thousands of years.

Hodmedod's, which works exclusively with UK farmers and growers and sells camelina seed for food use,[21] expects to be supplied by at least eight different camelina growers this year, including a certified organic camelina grower close to the Brooms Barn trial site in Suffolk. Other retailers sell UK-grown camelina oil direct to the public, including Northstar Lipids[22] and Aromantic Natural Skin Care[23].

In addition to the small, but growing, commercial market for UK-grown camelina, it is important to note that *C. sativa* it is a popular cover crop. Cotswold Seeds, for example, lists camelina as a "a component of over winter wild bird seed mixtures and game cover"[24]. Such uses are not easy to track and present a significant opportunity for GM volunteers to become established.

3.3. The proposed containment measures are inadequate

Given the ecological concerns that we have outlined above, and the growing use of camelina as a commercial and cover crop, it is imperative that the experimental plants – and reproductive material produced by them – are contained securely within the trial. However, the applicant has given very few details of their plans to prevent escape or monitor for its effects both during and after the proposed trial period.

The risk assessment included in Part A4 of the application acknowledges that "many organisms will encounter the modified *C. sativa* plants in the field trial" but mitigation measures appear to be limited to "a deer-proof fence with lockable gates" (mentioned in Part A1, paragraph 26) and "Appropriate physical barriers and/or deterrents … employed to minimise access by large mammals and birds" (in the risk assessment in Part A4). Even if one is happy to trust the applicant's judgement on what level of barrier or deterrent is "appropriate" and effective, such measures will not deter small mammals or insects.

In the risk assessment included in Part A4 of the application, the applicant states that "*C. sativa* is an annual species that requires active management to out-compete more weedy plants. Left unmanaged, it does not establish well in nature and thus has a low base line of invasiveness and persistence." However, researchers seeking to fill knowledge gaps regarding yield, weed competition, and pollen-mediated gene flow found in 2019[25] that "Camelina yields were the same with or without weeds, showing competitive ability in low-management conditions" leading the team to conclude that "camelina has traits commonly associated with weediness" including rapid germination and a short lifecycle.

The same 2019 study found that Camelina flowers attracted pollinating insects including honey bees and four other species of Hymenoptera as well as Diptera, Lepidoptera and Coleoptera. Also that wind-blown pollen was present 9m beyond the edges of the field. As stated in its conclusion, this research "demonstrated for the first time that pollen dispersal could occur through honey bees or wind" and that "introduction of this alternative crop must be balanced with 'duty of care' which asks for predictive ecological risk assessments and risk management strategies."

Since the 2019 study, further research in 2021 has again demonstrated that camelina is pollinated by honey bees[26]. A third study, also published in 2021, concludes that pollen concentration "supports a minimum isolation distance of 10m between *C. sativa* crops to maintain the gene flow rate < 0.01%."[27] The authors of this study go on to express the view that their work "will be useful for predicting and managing pollen-mediated transgene flow in GE *C. sativa,* providing distances useful for planning biocontainment of experimental field trials" so it is particularly disappointing that the applicant has not updated the information included in their application regarding dissemination of *C. sativa* (in Part A1, paragraph 6 of the respective applications) since their first application for a related field trial in 2014.[28]

Of even greater concern is the applicant's scant detail on what measures will be taken to prevent and monitor escape from the trial. In Part A1, paragraph 34 they state that "Trial design will be finalised depending on the number of lines to be evaluated in the field" and that "The area containing the GM trial plots **will have the option** of being surrounded by a non-GM pollen barrier" [our emphasis]. Containment is not an optional extra and, if this trial is allowed to proceed, the Secretary of State should require – as recommended in the independent research study noted above – a minimum distance of 10m between each experimental plot and a further isolation area, incorporating a pollen barrier of *C. sativa* planted to flower synchronously with the GM camelina, surrounding the entire trial site.

In response to previous related trial applications (18/R08/01 and 19/R08/01) the Secretary of State (under ACRE's advice) has twice required that "*the trial sites should be managed to minimise the persistence of Camelina on them and the experimental plots monitored for two years post-harvest before termination of monitoring can be considered.*"[29] We are extremely concerned to see that the applicant has disregarded this previous requirement and proposes instead to only monitor the trial sites for one year: "*The trial sites will be monitored regularly (at least weekly) during the growing period (May-Aug) and after the termination of the trial during the following year.*" (part A1, para 38).

The proposed GM field trial should not proceed until significant additional and detailed work has been completed to assess and mitigate the risk of escape, contamination of UK camelina crops and/or the establishment of volunteers in other areas.

4. THE PROPOSED TRIAL RAISES SIGNIFICANT ETHICAL CONCERNS WHILE OFFERING NO NET BENEFIT TO SOCIETY

4.1. Human and other mammalian genes have been inserted into the GM camelina

The list of genetic elements involved in the proposed field trial features a wide range of donor and source organisms including mammals. The presence of synthetic copies of human, cattle, goat and mouse genes will be of grave concern to many members of the public, for whom such uses raise significant, potentially insurmountable, ethical questions.

Many faiths have strict rules on the interaction between humans and other animals. For example, mice and other "crawling creatures" are identified in the Torah[30] as unclean and forbidden within a kosher diet. Anthropophagy, meanwhile, is taboo in all modern cultures. The proposed field trial does not, of course, include actual flesh from humans or other mammals but the applicant clearly identifies the genes in question as being derived (via synthetic copies) from the named species. This implies that the genes are unique to the respective species and raises fundamental questions about the essential nature of species boundaries.

It is common for cultural and faith-based perspectives on technological developments to be dismissed as "unscientific", but this is both unjust and inaccurate. Many individuals have already expressed a high level of disgust about the use of human and mammalian genes in the proposed field trial. Lay people commenting on these issues may not always communicate their concerns in scientific terms, but they are nonetheless largely based on a deep understanding of the potential for unintended consequences. The proteins that will be synthesized by these genes are animal proteins – in one instance a human protein – and as such they have no place in plants. The biochemical pathways which these animal proteins will catalyse are not part of the camelina plants' natural equilibrium and may unbalance other pathways in unpredictable ways. In this context the impact of exposing terrestrial wildlife to oils only naturally produced at sea (see 2.1, above) should be understood not as a singular event but as just one example of what can go wrong when novel compounds are introduced into a delicate ecosystem.

The genetically modified camelina should not be allowed to be grown in open field trials until an ethical review has been conducted by a suitably qualified, independent body. In addition, no release should be allowed until a full assessment has been made of the potential toxicity, allergenicity and other impacts associated with the presence of human and other mammalian genes.

4.2. Cultivation of GM crops will not improve the sustainability of the aquaculture industry

The applicant argues, as they have done with previous GM field trials, that a deliberate release of GM camelina producing EPA and DHA is justified as a means of improving the sustainability of the aquaculture industry.

The idea that it is essential for humans to consume fish to achieve a healthy intake of fatty acids is called into question by a number of factors, not least the healthy lives lived out by generations of vegetarians and others who simply do not like eating fish. Omega 3 fatty acids (including some EPA and DHA) are available from meat and dairy sources (especially those from organic or other pasture-fed livestock[31]) and humans are able to synthesise EPA and DHA from shorter chain omega 3 oils found naturally in plants. These include new plant sources, such as oil from the Ahiflower (*Buglossoides arvensis*) which launched in the UK in 2015[32].

It is likely, though, that aquaculture will continue to grow and we acknowledge the significant concerns that its practices raise. However, the wild fish which have traditionally been harvested to supply the aquaculture industry are not primary producers of LC-PUFAs but accumulate them by consuming marine algae. The potential for microalgae to be cultivated and used as a feed for aquaculture has been clear since before the applicant's first open field trial of GM camelina in 2014[33]. In the intervening years, studies have shown that the use of marine microbes can replace fish oil in aquaculture feeds[34] and understanding has increased that a circular bioeconomy framework is required to achieve sustainability in aquaculture[35]. As stated in a 2021 paper for Reviews in Aquaculture,[36] "Aquafeed 3.0 will be based on raw materials that are nutritionally superior and closer to the natural diet of many carnivorous aquatic species than the terrestrial plant and animal by-products currently being used."

On a practical level, EPA and DHA supplements derived directly from algae have become increasingly available as human food supplements[37] and, in 2019, Veramaris opened a full scale zero-waste production facility in Nebraska, producing omega-3 oil for the aquaculture industry by fermenting natural microalgae[38].

The GM camelina plants in the proposed trial have also been engineered to accumulate astaxanthin. Astaxanthin is promoted to the public as a dietary supplement but is classified as a food dye and is used in aquaculture to give farmed fish an appearance similar to their wild-caught relatives. Synthetic astaxanthin is widely used in the aquaculture industry but, once again, algal sources are already beginning to provide a sustainable alternative. As a 2021 paper in Algal Research[39] said "Owing to the great advantages of microalgae-based astaxanthin in the aspects of sustainability and safety, microalgal astaxanthin is emerging into the limelight."

In conclusion, the applicant is treating camelina as a biological chassis for industrial products, with the ultimate aim of converting arable land that should be growing high quality food for direct human consumption into an open-air factory producing micronutrient additives for industrially farmed animals and/or pharmaceutical products. The scale of the proposed field trial; the wide range and specific nature of the traits being introduced; and the absence of vital information on both the genetic modifications themselves and measures that will be put in place to prevent escape and outcrossing combine to present an unacceptable risk for no public benefit. In addition, the proposed field trial raises significant, and novel, ethical questions that have not been adequately considered. We request, therefore, that the Secretary of State denies consent and prevents this open-air field trial going ahead.

Yours faithfully

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References

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