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ANIMAL PRODUCTION SCIENCE

PERSPECTIVES ON ANIMAL BIOSCIENCES

Perspective on scientific truth versus scientific evidence; maintaining integrity in global food systems

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ABSTRACT

Sciences related to animal agriculture are threatened by agenda-driven scientists. It can be shown that too many peer-reviewed articles have dubious quality, including high-profile ones. Better training and higher review standards for rigour, reproducibility and transparency should help alleviate the problem. However, they will not solve the challenge posed by 'cargo cult scientists', as characterised by Richard Feynman. Such agenda-driven scientists pursue an *a priori* mission, whose achievement justifies any means, even if it includes to willfully manipulate and interpretate data, or to violate good practices of integrity in the sciences. This review explores in three prominent case studies in animal-sourced food related sciences where the dividing line might be between science being poorly practiced (which can be remedied), and scientific channels being abused for agendas (which should not be tolerated). So as to guard both as the individual scientist and as the discipline against the intrusion of such agenda-driven science, this article suggests adopting the Popperian stance to generally refrain from the concept of seeking or establishing a 'scientific truth', and instead to restrict oneself to presenting the 'scientific evidence', both in terms of what the evidence shows, and what it does not.

Keywords: animal agriculture, cargo cult scientist, conflict of interest, food systems, integrity, reproducibility and transparency, rigour, scientific evidence, scientific truth, white-hat bias.

Introduction

Scientific research integrity is the cornerstone of sustainable global food systems. Across scientific-research disciplines, there is a growing attention on uplifting standards of scientific research and publication. The aim is to bolster credibility and standing of science in society, where science is seen to be both the victim and the perpetrator of a post-truth era. Systematic examinations of published research results have repeatedly shown outright false, severely biased or irreproducible findings (Brainard and Jia 2018). Retraction Watch estimates that one in 50 papers would meet the criteria for retraction (Oransky 2022). In a paper that has been viewed 3 million times and cited more than 7000 times, Ioannidis (2005) laid out a proof, how most published research findings are false according to him. In a 2016 paper, Ioannidis (2016) lamented in the abstract about 'the mass production of redundant, misleading and conflicted systematic reviews and meta-analyses [. . . of which . . .] few are both non-misleading and useful.' So as to improve scientific quality, editorial boards of scientific journals (for instance, McNutt 2014, Editor-in-Chief of Science, or Horton 2015, Editor-in-Chief of *The Lancet*), research-funding institutions (for instance, National Institutes of Health, NIH 2023) and universities (for instance, Indiana University, Valdez *et al.* 2020) require from scientists increasingly higher proofs of rigour, reproducibility and transparency (RRT) standards before their work can be conducted, financed or published. This general state of science appears to apply to the animal-related sciences as well. For instance, a meta-analysis of 3.62 million publications in 25 different disciplines showed that the prevalence of selectively presented statistics (and therefore potentially false) in animal-related sciences, such as nutrition and dietetics, animal and agricultural, ecology and earth, zoology or public health, is largely equal to, or worse than the average in the other disciplines (Cremieux 2023). Instead, when correctly done, quantification

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ensures advances in the nutritional sciences, agriculture, animal production and agronomy. Correctly executed quantitative evaluation of evidence is the core strength of the scientific approach used by these disciplines and has been responsible for major gains in food production efficiency over the past century (Pethick *et al.* 2023).

Research is being conducted into why researchers may not be following high RRT standards. Reasons are, for instance, pressure to publish, lack of funding, lack of training in scientific methods, peer-review pressure to acknowledge legacy findings and similar (Anderson *et al.* 2007; Valdez *et al.* 2020). Other researchers systematically outline reasons for why it is difficult to retract and correct published results (Allison *et al.* 2016). To clarify the standards for reproducibility and replicability in the sciences, the US National Academies of Sciences, Engineering and Medicine (NAS) felt compelled to publish a far-reaching Consensus Study Report in 2019 (National Academies of Sciences, Engineering, and Medicine 2019). An article in Plato illuminated the many different expressions and origins for missing reproducibility (Plato 2018). In 2014, *The Lancet* launched a five-part series on improved research design called 'Increasing Value, Reducing Waste' (The Lancet 2014).

This article advances the proposal, that while improving the standards of RRT is much welcomed, by itself it will not resolve all problems of poor science. Epistemology has long been struggling with a more basic conflict, namely requests by society for science to be relevant by producing truths. This request unfolds a dynamic that can lead to four types of poor science, which I will respectively call 'sloppy, biased, opportunistic and agenda-driven' science; it is the last one that threatens the integrity of science the most. Following epistemological considerations, this article investigates, in three case studies, specifically within the domain of animal-related sciences, how societal interference may be leading science away from objectivity and discovery towards confirmation of agenda-determined outcomes. The selection of these case studies represents three of the highest-profile science/global public-policy interactions between the years 2015 and 2021 on the question of the healthiness of meat consumption. While recognising the limitations of case studies, given the prominence and significance for global public policy of the three cases here presented, they can be seen as paradigmatic indicators of a wider-spread phenomenon (Flyvbjerg 2006). I will end with the observation that to guard both the practitioners and the users of science against loss of integrity, it is advisable to delete the concept of 'scientific truth' from the mental toolkit.

Epistemological considerations

In a high-profile OECD/European Union conference called 'Governing better through evidence-informed policy making' (OECD 2017), it was observed that 'evidence is necessary to fight against a post-fact/fake news world', and that 'scientific evidence competes with values, feelings, and emotions of politicians and constituents, and that good evidence is only one element in political decision making.' To be useful to policy, scientists should be 'building compelling narratives . . . be concise and use simple language', while at the same time 'be clear and give a detailed understanding'. To paraphrase, this sort of 'speaking truth to power' which the OECD/EU workshop is advocating for, is a sociological construct of 'a belief that scientists, unimpeded by economic self-interest or partisan bias, will deliver honest and often uncomfortable truths to those in positions of power' (https://sociology.iresearchnet.com/sociology-of-science/speaking-truth-to-power/). The origins of such 'speaking truth to power' are rooted in the 1950s in the US American Civil Rights movement, and have since evolved to describe the essence of 'good and pure' science (and journalism for that matter), not the least through the work of Robert K. Merton, namesake for the 'Mertonian norms.'

There are at least two problems with this ideal. First, it ignores that 'the truth' is a controversial concept on its own. In various social-science disciplines, prominently in philosophy, sociology and political science, researchers are debating what truth is, what truth means, and how relevant truth is. Respective theories on the nature of truth are, for instance, called correspondence, coherence or pragmatic and more. This debate shall not be repeated here (for some recent philosophy essays on truth in science, see Massimi 2019 or Brüssow 2022). In short, the problem with truth, from an epistemological point of view, is that it is indivisible. There cannot be several different truths about the same thing, and thus if a truth was ever found, it would end further scientific inquiry into the matter, which, as history has shown often enough, is usually premature. The second major problem, which may be even more important, is that not only does truth speak to power, but power also speaks to truth. The permeability of science to the values it is competing with in the societal discourse is well understood (for instance, Silva 2014). Robert Hoppe observed in 1999 that 'increasing scientification of politics leads to a politicisation of science' (in abstract). Similar is occuring in animal-related sciences. Blaxter and Webster (1991) is worth quoting here in full, as follows: 'The examples I have given of the increasing use of incomplete or selected information, or the acceptance of views given on the basis of limited and inconclusive scientific data, or the ignoring of informed advice altogether, in formulating public policy, is extremely worrying. In the years to come I am of the opinion that policies will be adumbrated by various pressure groups on the basis of little evidence, pursued assiduously by them, and eventually accepted on the basis that, although not scientifically defensible, they have become politically expedient' (p. 268, concluding paragraph).

The challenge is as old as science itself, with the starting line in history generally considered being Aristoteles. Before

Aristoteles, Socrates created synthetic truths in his famous dialectic approach, which is ultimately an induction, a generalisation from the particular to the universal. But then his student Aristoteles instead emphasised deductive logic, such that a universal theory can be tested for its correctness in the particular and holds provisionally right only until a particular has been found that disproves it. The theory that all swans are white is only provisionally correct until a black swan is found. The practical result of Aristotelean logic is that science can establish with certainty only what is not. In the 20th century, Karl Popper expanded this falsification paradigm. In his essay 'Knowledge without authority' Popper is adamant that the only useful pursuit of science is to engage in falsification exercises and that theories that do not have falsification options are useless. 'There is no criterion for truth at our disposal . . . .but we possess criteria which, if we are lucky, may allow us to recognise error and falsity.' (Popper 1960, p. 55).

The aforementioned NAS Consensus Report 2019 signposted in its table of contents that 'science aims for refined degrees of confidence, rather than complete certainty.' It further stated that 'the robustness of science is . . . .represented by a more holistic web of knowledge reinforced through multiple lines of examination and inquiry' (National Academies of Sciences, Engineering, and Medicine 2019, p. 143) and then finished with the recommendation that 'scientists should take care to avoid overstating the implications of their research and also exercise in their review of press releases . . . .' (National Academies of Sciences, Engineering, and Medicine 2019, p. 160). With these views, NAS positioned itself firmly on an epistemology as expressed by Popper. While the study of Popperian epistemology is a common staple for scientists-in-training of any social and natural discipline, strict adherence to its application is less popular. In the tradition of Karl Popper's epistemology, this article suggests, that when a subject is as politically contested and fought over by societal stakeholders as the fields of the animal-related sciences are, then the safest course for integrity science is to stay close to Popper, that is, to aim to prove what is not true and accept that an insight will only be transiently applicable.

Four categories of poor science

1. *Sloppy science*. A spread sheet on a laptop today has more options to compute statistics than a super computer had in the 1960s. Statistics packages such as the widely used SPSS are even more powerful. But the corresponding art of rigorous analytical design has diffused much slower. Access to computing power had already outstripped knowledge of statistics among scientists by the 1970s, prompting David Sackett to publish his canonical catalogue of 35 different kinds of technical flaw in 'analytical studies' (Sackett 1979). He noticed an 'ebullition of case-control studies in progress' (p. 51), and felt the need to enlighten researchers of all the different ways in which hapless study and analytics design will inadvertently slant the results and diminish the value of the research. Unaware researchers would not even know about the faults in their analysis, unless they specifically checked and tested for these flaws. As outlined in the introduction, rising emphasis on rigour to avoid false scientific findings due to sloppiness is welcome and can only but improve the quality of science.
2. *Biased science*. However, these RRT technical training efforts will not capture all cases. A second kind of poor science was described by Cope and Allison as so-called white-hat bias (WHB), exemplary for in the field of obesity research (Cope and Allison 2010). Cope and Allison defined it as 'bias leading to distortion of research-based information in the service of what may be perceived as righteous ends' (in abstract). Under WHB, the researcher might be perfectly technically capable of correct study design but is prone (almost) subconsciously to selective bending of the data to make it meet a pre-specified target. Nonetheless, a bias is not intent, but something that one is not fully aware of. Biased results owing to such WHB are a false outcome for science, and should be rectified when the bias is discovered, but they are not intentionally wrong. Ultimately, rigourous peer review and a ready willingness of journals to retract articles can counteract WHB.
3. *Opportunistic science*. A third kind of poor science production that goes beyond RRT and WHB, is intentional manipulation of the scientific method and then to obfuscate the manipulation behind intelligent-looking gobbledygook for reasons of financial or career gain. One increasingly common way to address the risk of such intentional manipulation occuring is through the process of declarations of conflicts of interest (COI), especially financial ones. The assumption in this approach is, that a declared actual or potential financial COI would expose incentives to compromise the practice of scientific method and thus caution the user of such results to its potential falsity. Whether or not the COI approach solves the problem is much contested (Fisch 2018; John *et al.* 2019). Moreover, beyond financial COI, there may also be career-interest conflicts, network-based conflicts and ideological conflicts (Bero and Grundy 2018). In animal-related sciences, it has become increasingly common to declare one's dietary habits in conference presentations and publications (vegan, vegetarian, pescatarian, omnivore, etc.), on the presumption that such dietary preferences may be clouding one's ability to conduct science objectively.
4. *Agenda-driven science*. It is this fourth kind of false science, which is the most threatening, which is when scientists feel that it is their right and duty to manipulate the scientific evidence with intent, so as to pursue an agenda they believe in. They are neither poorly trained, nor biased, nor interested, they are zealous. For them, fitting the evidence towards an end, is to make the right

goal justify the means. Neither RRT training, nor peer review nor any degree of COI disclosure will capture these cases. The existence of such malpractice is well established, although the extent of it is not.

Richard Feynman in his famous 1974 Caltech commencement address, coined this term 'cargo cult science' (Feynman 1974), as follows: 'In the South Seas there is a cargo cult of people. During the war they saw airplanes land with lots of good materials, and they want the same thing to happen now. So they've arranged to make things like runways, to put fires along the sides of the runways, to make a wooden hut for a man to sit in, with two wooden pieces on his head like headphones and bars of bamboo sticking out like antennas – he's the controller – and they wait for the airplanes to land. They're doing everything right. The form is perfect. It looks exactly the way it looked before. But it doesn't work. No airplanes land. So I call these things cargo cult science, because they follow all the apparent precepts and forms of scientific investigation, but they're missing something essential, because the planes don't land.'

Agenda-driven scientists are cargo cult scientists. They appear to be practicing the scientific method, by engaging in data analysis, drawing conclusions, publishing results, peer-reviewing themselves, disclosing potential conflicts of interest and teaching students. Despite practicing in this form, they achieve no good progress, neither for themselves, nor for society but the agenda they promulgate. Their airplanes do not land. Feynman (1974) suggested that the problem is not only a lack of understanding of how the form of these scientific behaviours operates to produce progress for society. He spells out that the deeper reason why cargo cult science ultimately does not work is because it lacks integrity. His parting wish to the graduates was as follows: 'the good luck to be somewhere where you are free to maintain the kind of integrity I have described, and where you do not feel forced by a need to maintain your position in the organization, or financial support, or so on, to lose your integrity. May you have that freedom.'

Three case studies where science may have or be about to lose its integrity

The following three case studies serve to examine where there might be the dividing lines among these four types of poor science leading to false outcomes.

The IARC Working Group report on the Carcinogenicity of Red Meat

The first case study is the IARC (International Agency for Reseach on Cancer, a suborganisation to the World Health Organisation WHO) Working Group report on 'Carcinogenicity of consumption of red and processed meat', which was published on 26 October 2015 in *The Lancet*. The IARC group consisted of 22 members from 10 countries. According to both the press release by WHO, with a four-page question and answer (Q&A) session on its website, as well as a short article in *The Lancet* (Bouvard *et al.* 2015), the group had 'assessed more than 800 epidemiological studies . . . ', and, on this basis 'classified consumption of red meat as probably carcinogenic to humans (Group 2 'classified consumption of red meat as probably carcinogenic to humans (Group 2A)' and processed meat as 'carcinogenic to humans (Group 1)'. Three years later, the extensive documentation was published as a monograph (IARC 2018). At the time of writing this perspective (July 2023), according to PlumX metrics, the *Lancet* article has been cited 1190 times, and was used 81 times in public-policy documents, including several times in United Nations global-policy documents. During the second quarter of 2023 alone, the *Lancet* article was quoted 51 times and used 12 times in public-policy documents. While the IARC evaluation is already 8 years old, it is still prevalently used and cited.

In the *Lancet* article, the IARC group members briefly summarised the balance of their evidence on which they base their evaluation. For instance, they wrote in the eighth paragraph that 'Chance, bias, and confounding could not be ruled out with the same degree of confidence for the data on red meat consumption, since no clear association was seen in several of the high-quality studies and residual confounding from other diet and lifestyle risk is difficult to exclude. The Working Group concluded that there is limited evidence in human beings for the carcinogenicity of the consumption of red meat.' Two paragraphs later the authors then went on to explain 'the mechanistic evidence for carcinogenicity was assessed as strong for red meat' (they mentioned N-nitroso compounds (NOC), haem iron and hormonally active agents (HAA)), which was then qualified by the WHO Q&A 11th answer, namely that 'Eating red meat has not yet been established as a cause of cancer.'. As the only quantifying piece of information, the text mentions 'A meta-analysis of colorectal cancer in ten cohort studies reported a statistically significant dose–response relationship, with a 17% increased risk (95% CI 1.05–1.31) per 100 g per day of red meat and an 18% increase (95% CI 1.10–1.28) per 50 g per day of processed meat.'. The *Lancet* article concluded that for its carcinogenicity evaluation, the 'Working Group took into consideration all the relevant data, including the substantial epidemiological data . . . and the strong mechanistic evidence.'. The authors did not explain how 'no clear . . . limited evidence' in the statistical associations become 'substantial epidemiological data', nor how 'strong mechanistic evidence' squares with 'no establishment of causality'. The contradictions between their own few paragraphs of text and their conclusion to identify red meat as probably carcinogenic were left for the reader to resolve. The same can be said for the separate evaluation of processed meats.

The methodological weaknesses of the IARC evaluation have since been variously described and published. A comprehensive critique came from Klurfeld (2018), who was himself member of that IARC Working Group. He explained the statistical inadequacy of using relative risks of less than 200% for casting any judgement, let alone just 17% as used by IARC. For instance, relative risk of lung cancer from smoking cigarettes would be 1000–3000% (p. 6). He also explains the difference between relative risk and absolute risk, where if values of 17% are applied to what are low incidence rates such as specific cancers, then the resulting increased absolute risk is outside fair measurability, or indeed significance for the consumer. Furthermore, to illustrate the inadequacy of statistical associations due to confounding factors for making such far reaching evaluations, Klurfeld (2018) also quoted one of his own previous analyses showing that red meat eaters have a statistically robust higher relative risk of 28% over white meat eaters of dying in accidents (p. 8). Surely, however, red meat consumption does not cause more accident deaths. Whatever association red meat may have with mortality or chronic disease, it is small and contextual, thereby depending on inter-individual differences and vulnerabilities, dose, preparation methods, quality of background diets, and overall lifestyles (Johnston *et al.* 2023). Regarding the mechanistic evidence, Kruger and Zhou (2018) showed in a review of all available material that studies of NOCs and haems 'have not provided sufficient documentation that the mechanisms studied would contribute to an increased risk'. Boobis *et al.* (2016) thoroughly explained that the whole methodology of hazard identification utilised in the IARC monograph series generally 'have become outmoded and serve neither science nor society' (title). Also in 2016, the Editorial of *The Lancet Oncology* equally called for an improved methodology for carcinogen assessment, as the current one could be flawed (The Lancet Oncology 2016).

The balance of the epidemiological evidence on meat consumption was also comprehensively questioned by the NutriRECS consortium evaluation from the year 2019, which concluded after reviewing each available epidemiological study, that there is 'only low to very-low certainty evidence' for any mortality risk, and that therefore adults might 'continue current unprocessed red meat consumption.' (Johnston *et al.* 2019, abstract). A publication in *Nature Medicine* in October 2022, reviewing the same evidence again, arrived also at essentially the same conclusion, that 'while there is some evidence that eating red meat increases risk of chronic disease, it is weak and insufficient to make stronger or more conclusive recommendations.' (Lescinsky *et al.* 2022, abstract). Moreover, in 2021, the Scientific Council of the World Farmers Organisation released a review (WFO 2021, the author of this article was also one of the co-authors of this WFO review), where it was demonstrated that the IARC statement of '17% increased risk per 100 g per day of red meat' can be attributed primarily to just one study conducted in 2005, and that the data in that study was significant only for pork meat, and only after statistical enhancement, according to IARC's own assessment.

Overall, it can be concluded, that the 2015 IARC evaluation has been discredited along every dimension. It has been shown methodologically, epidemiologically and mechanistically to be devoid of supporting scientific evidence. It does not meet the before-mentioned National Academies of Sciences, Engineering, and Medicine (2019) robustness standard of being a 'holistic web of knowledge reinforced through multiple lines of examination'. Given the very high-profile public-policy significance of this document, why has this IARC evaluation not been retracted or been reassessed, given all of the substantial counter-evidence described above? It seems also fair to ask, on what basis did the 22 IARC Working Group members reach their evaluation to begin with, if there was such degree of insufficient scientific evidence as shown by their own documentation? Is it possible that they followed an agenda they established beforehand, for which scientific evidence is helpful, but not mandatory?

The Global Burden of Disease 2019 investigations

The second case study concerns the Global Burden of Disease (GBD) 2019 study. When it was published, some observers (concerned scientists) noticed a conspicuous jump of dietary risks and deaths associated with diets high in red meat, compared with the previous GBD 2017. There was a 36-fold increase to a total of 896,000 deaths (GBD 2019 2020). Deeper analysis of the publication showed that the theoretical minimum-risk exposure level (TMREL) was reduced to 0 g per day, making red meat toxic from the first bite. Additionally, it seemed that none of the well-established protective health effects were assigned. Underlying evidence for such a strong statement seemed to be lacking in the documentation. Furthermore, against the stated guidelines of *The Lancet*, no PRISMA (www.prisma-statement.org) or GATHER (https://www.who.int/data/gather/statement) statements could be found, both of them being instruments in health-related sciences to ensure that the necessary minimum of information is provided for independent review.

The observers eventually succeeded to publish a letter in *The Lancet* in April 2022, asking whether the estimate of deaths attributable to red meat intake in GBD 2019 is reliable (Stanton *et al.* 2022). In the authors' reply, the GBD collaborators then admitted that the setting of TMREL to zero was methodologically not adequate and will be revised for GBD 2020 (Murray 2022). Furthermore, the main author Christopher Murray has separately confirmed that GBD 2019 is not PRISMA-compliant (A. Stanton, as per an email conversation received from C. Murray, 2023). The observers note that according to the guidelines of *The Lancet* and the Committee on Publication Ethics (COPE) and the International Committee of Medical Journal Editors (ICMJE), it is mandatory to immediately correct all such known errors. This has so far not been the case, while at the same time GBD 2019 keeps

on being referenced in important public-policy documents such as the Europe's Beating Cancer Plan of the European Union. In a further letter to *The Lancet*, another group of observers are much concerned about the 'troubling assumptions behind GBD 2019 on the health risk of red meat' (Gordon-Dseagu *et al*. 2022, title). Finally, Christopher Murray was himself the senior last name author for the above-cited Nature Medicine publication in October 2022 arriving at the conclusion that the evidence against unprocessed red meat '....is weak and insufficient to make stronger or more conclusive recommendations' (Lescinsky *et al*. 2022).

Similarly, to the IARC study of 2015, the next steps are still outstanding. Scientific protocol, guidance and rules unequivocally demand a retraction and correction of such medically relevant key stone publications, if they have been found to be erroneous. Why is GBD 2019 still unretracted? How is it possible that a GBD evaluation can reach results with such far-reaching implications for global public policy, if there was insufficient scientific evidence as Murray stated himself?

Sustainable livestock at United Nations Food Systems Summit 2021

The third case study pertains to global public-policy proceedings at the United Nations Food Systems Summit (UNFSS) in 2021, which were supposed to be underpinned by science. In the Summer of 2019, United Nations Secretary General Antonio Guterres announced he would convene a Food Systems Summit as part of the Decade of Action to achieve the Sustainable Development Goals (SDGs) by 2030, as follows: 'The Summit will launch bold new actions to deliver progress on all 17 SDGs, each of which relies to some degree on healthier, more sustainable and equitable food systems.' (UN 2019). The initiative became delayed by the outbreak of the pandemic, and it is not publicly known how the leadership structures of the Summit proceedings were chosen. By November 2020, the Summit preparations *de facto* kicked off in a large symposium of panels, discussions and presentations called 'Bold Actions for Food as a Force for Good' (all online because of the pandemic). It was hosted on an online platform provided by World Economic Forum and could be attended only by becoming a paying member of the World Economic Forum. This event was important because, for the first time, the organisation of the Summit proceedings was made comprehensively public, with its five action tracks, their staffing and agendas. The November 2020 event had the following as its first objective: 'to agree on an initial set of bold actions and science-based principles to change the food system' (UN 2020).

As one of the five action tracks, Action Track 2 (AT2) had the theme of 'Shift to sustainable consumption patterns'. Its chair was Dr Gunhild Stordalen, who is the executive chair of the EAT Initiative, founded by the Stordalen foundation, the Stockholm Resilience Center under Professor Johan Rockström and the Wellcome Trust (EAT 2023). On the EAT website it says that Stordalen is 'a published scientist... with a passionate commitment to food system transformation', and that she is a Young Global Leader of the World Economic Forum, as well serving on the World Economic Forum Stewardship Board on Food Systems (EAT 2023). Stordalen described her ambition for her AT2 leadership as follows: 'International summits rarely change the world by themselves, and especially not now given the global political climate. Our goal is therefore to take full advantage of the Summit to build an unstoppable global movement for change that we can keep growing well beyond the Summit, to force the kinds of far-reaching changes that the world now desperately need.' (EAT 2020). How these changes will be achieved was made clear in the preceding EAT-*Lancet* Report, where Johan Rockström was the second author, and Christopher Murray (of the GBD) the last name author, as follows: 'The scale of change to the food system is unlikely to be successful if left to the individual or the whim of consumer choice. This change requires reframing at the population and systemic level. Hard policy interventions include laws, fiscal measures, subsidies and penalties, trade configurations and other economic and structural measures.... countries and authorities should not restrict themselves to narrow measures or soft interventions. Too often policy remains at the soft end of the policy ladder' (Willett *et al.* 2019, p. 478). Essentially, the entire leadership of AT2 was staffed with persons closely associated with the EAT Initiative. The public positioning of the choice for AT2 leadership left no doubt, although not explicitly mentioned like this, that the AT2 aims were to significantly reduce the amount of meat consumption, accompanied by a corresponding reduction of livestock, and, by self-declaration as described above, to force through this transformation by authoritarian 'hard' measures against the will of the consumer where necessary.

By May 2021, the Summit preparations had reached a major impasse. Most of the various stakeholder groups representing farmers, civil society and industry could not find common ground with representatives from AT2 on the role of livestock in a global food system. The transformational reduction of livestock envisioned and argued for by AT2 did not find approval among most of the other concerned stakeholder groups. To unblock the situation, it was decided to arrange a solution cluster called 'Sustainable Livestock' cutting across all action tracks, with three focal-point individuals nominated respectively by the World Farmers Organisation (WFO), the International Livestock Research Institute (ILRI) and CIAT Bioversity. The author of this article was the focal point appointed by WFO and therefore has knowledge of the proceedings first-hand. The cluster was installed on 17 May 2021 and tasked to curate a two-pager solution paper among an open-membership working group with approximately 70 different organisations. Four weeks later, 15 June 2021, the cluster had created such a document, which found approval by all these stakeholders.

Its tenor could be paraphrased with 'Much improvement is necessary, but livestock is part of the solution, not part of the problem' (the author's summary, P. Ederer). Two days later, on 17 June 2021, the three focal-point individuals were asked by the Summit leadership group to incorporate additional input from other stakeholders that had chosen not to participate thus far. These were representatives from Chatham House, Wellcome Trust, Oxford University, New York University, the Good Food Fund, 50by40, the Good Food Institute, Compassion in World Farming and FAIRR, with each of them being closely associated with AT2. A week later, inputs received from this group were as follows: 'That is nonsense', 'On farmer-driven roadmaps: in other areas such as energy, would it be acceptable for oil producers to decide a roadmap?', 'It is absurd to proposition a growth in the livestock as a solution', 'It is irrelevant that livestock farming has provided food, clothing, power, manure and income and acted as assets, collateral and status. Fossil fuel has done many of the same things', 'We are a 38 trillion investor network calling for sustainable agriculture system which importantly includes a shift to plant-rich diets and lower quantities of high-quality meat and dairy consumption' and similar (these quotes are taken from email conversations that were shared among many members of the solution cluster and therefore are neither private nor confidential).

It is legitimate for the individuals from these organisations to hold these views and express them as part of a stakeholder exchange. However, the focal points, and indeed all proceedings throughout the Summit, had been asked to ground proposals in either solid scientific evidence or existing practiced solutions. It was the view of the focal-point leaders, that the contributions of the 17 June 2021 group met neither of these two criteria. Since the solution cluster 'Sustainable Livestock' again could not agree on a joint position after the 17 June 2021 group began to weigh in, the proposal was then to create three different two-page solution papers with one jointly drafted opening paragraph, respectively called A, B and C papers, and then each respective stakeholder group could provide its scientific and practice evidence for each preferred solution pathway. The three solution papers would then become part of the Summit proceedings and be the starting point for so-called post-Summit Coalitions of Action. The three papers are available as online Supplementary material to this article (until Summer 2022, they were available for public download on the UNFSS website). The A-paper called 'Best Practices and Technologies' was similar to the first solution paper presented in mid-June 2021, calling for an emphasis on best practices, technologies and diversity to be a guide for rapid change, without defined targets for livestock numbers, but an acknowledgement that not enough livestock products are available to the global population (again, the author's summary, P. Ederer, see Supplementary material for the original papers). The B-paper called 'Grazing for Soil Climate and People' had a particular focus on grazing livestock. The C-paper called 'Aligning Production to Consumption' was essentially a summary of the positions of organisations closely cooperating with the EAT Initiative and AT2 that livestock numbers and animal-sourced food consumption need to be significantly reduced. By finding this compromise formula of three separate solution papers, the impasse was solved, and the Summit could proceed to its concluding pre-Summit meeting at the end of July 2021 in Rome, with every stakeholder group satisfied that its position was somehow represented.

Each of the three A, B, C papers was extensively referenced to scientific journal articles, public-policy documents or existing practice descriptions. The Scientific Council of the WFO (SC-WFO) checked the quality of the references of each of the three papers (the author of this paper being a co-author of the SC-WFO as well). In the A and B papers, the evaluation found three references each that were not correct, of 45 and 56 respectively. However, among the 53 references of the C-paper, 17 were wrong or irrelevant sources unrelated to the statement, 22 were relevant but said either nothing about or even the opposite of the statement, and 18 sources employed demonstrably weak or manipulative methodologies that could easily be disqualified (multiple mention possible). Only 11 of 53 sources were correctly attributed and supported the statement. That was the quality of the science provided by the C-group, which supposedly was the competence centre of AT2 and EAT on the subject (see Supplementary material for the detailed draft evaluation of the SC-WFO analysis. It was not officially entered into the UN FSS process, and is thus made available here for the first time to a wider audience).

Two examples shall showcase how manipulated the sources of the C-paper could be. In one instance, a statement was made 'that significant reduction in global consumption of meat and dairy is needed . . . .to minimise the use of antimicrobials'. This was referenced in footnote 15 to a well-known and respected Joint Scientific Opinion prepared by the European Medicines Agency and European Food Safety Authority in 2017 about antimicrobial agents. However, nowhere in that 245-page dense scientific treatise do these two agencies mention or imply that antimicrobial-agent use would be reduced, let alone minimised, via a reduction in the global consumption of meat and dairy. The second example is the well-cited Springmann *et al.* (2016). It was referenced twice in the C-paper of AT2 related stakeholders. Marco Springmann was also the co-author in the EAT *Lancet* 1.0 Commission, is a current Commissioner in the EAT *Lancet* 2.0 Commission, and was among the group who provided additional input on 17 June 2021. His 2016 article is called 'Analysis and valuation of the health and climate change co-benefits of dietary change'. According to PNAS where it was published, the article has been cited 707 times, and has been viewed a sizeable 460,000 times, so it is a successful article. In that work, the authors claim to have calculated that if all of humanity switched to a vegan diet, then 8.1 million deaths could be avoided per year on grounds of

improved health. The authors claim to have calculated this value based on the Global Burden of Disease (GBD) survey 2010. The vegan diet that they composed would avoid the GBD health risks of diets being low in fruit for 4.9 million avoided deaths, and low in vegetables yielding 1.8 million avoided deaths. Avoided deaths because of diets high in red meats falling away due to it being vegan, would contribute only 38,000 cases (according to GBD 2010, each value was extrapolated by some factor to adjust for population growth to then reach a total of 8.1 million avoided deaths). Clearly, the avoided death toll of the preferred diet had almost nothing to do with being 'vegan', and all with eating sufficient amounts of vegetables and fruits.

Springmann *et al.* (2016) is not a one-time exception in his publication record. In 2018, *Springmann et al.* published a follow-up study where they proceeded in the same fashion (2018 being funded by the Wellcome Trust and EAT, both among the 17 June 2021 contributors). They wrote 'Progressively replacing animal-source foods with plant-based foods led to progressive reductions in premature mortality of up to 12% in 2030'. But in the next sentence, they admitted that only a tenth of that reduction would be due to a reduction in red meat, the other 90% is due to an increase in vegetables, fruits and legumes. These latter food groups can be easily increased without having to reduce red meat as they are not mutually exclusive. So, framing these benefits as beneficial for a 'vegan' animal-sourced-food-free diet is false. Moreover, the analysis sayid nothing about white meat, dairy or eggs, which are also animal-sourced foods. The argument that these diets are called 'vegan' as a proper description for the parallel analysis of the environmental impact is disingenuous because similar manipulations can be identified in those just as much in both the 2016 and the 2018 works. (In the same article, Springmann *et al.* (2018) also modelled that a reduction of obesity and overweight by curtailing the provision of calories would decrease premature mortality by 8% (p. 456, fig. 2). This disregards that obesity is not a simple function of overeating calories, and paying no attention as to how this would be practically implemented. It is, however, a further example of the manipulative practice of science by Springmann *et al.* 2018). Nor has Springmann distanced himself from these articles in the meanwhile. In a letter to the editor of *Lancet Planet Health* in June 2023 (Springmann 2023), Springmann wrote that 'Eating a nutritionally adequate diet is possible without wrecking long term health, the planet or the pocket', and cited the 2018 article Springmann *et al.* (2018) as his primary evidence. There is a little sign in Springmann's work of NAS 2019 recommendation not to overstate the implications of research.

Discussion

If the poor science results shown in the three case studies are the results of agenda-driven scientists, and are not the result of too little training in rigour, too little peer review or too little conflict of interest exposure, then what might be their agendas? Ultimately, only the scientists involved would be able to tell. However, Feynman's description of cargo cult science may offer a hint that these agendas could indeed have cult origins. Early Seventh Day Adventism, Transhumanism, Effective Altruism or Animal Rights (distinct from animal-welfare studies) are recent reinterpretations of long-standing eternity cults whose spiritual roots can be traced all the way back to the Mesopotamian Gilgamesh, pharaonic Egypt or eastern mythologies more than 4000 years ago (Szűcs *et al.* 2012; Besnier 2013; Thomas 2017). Each of these modern cults have strong agendas about the role of animals in modern society and therefore seek to strongly interfere in animal-related sciences. Several of the additional 17 June 2021 contributors in the UN Food Systems Summit described in the third case study, have their roots in the Animal Rights cult or share overlapping funding sources and personnel with Seventh Day Adventism, Transhumanism or Effective Altruism promoters (Luneau 2020).

How can scientific treaties about the role of animals in society be told apart on whether they are agenda-driven or integrity-driven? There may be a signal by which they can be distinguished; according to the functionalism view in sociology, cults and religion thrive on unifying truths, aim to make the knowledge space smaller and thus create a coherent community. Integrity science seeks the opposite; it aims to widen and deepen the knowledge space and open ever new frontiers (National Academies of Sciences, Engineering, and Medicine 2019). Accordingly, agenda-driven scientists may be identified by terms such as 'scientific consensus' whose aim it is to choke off debate and proclaim an unchallengeable truth. Knowledge discovering scientists, instead, can be identified by having more questions than answers. Paraphrasing Feynman, the biggest difference between the two is that *the airplanes of the agenda-scientists fail to land – always*.

How is it possible that the false results of agenda-driven scientists gain traction in enlightened society and take room amidst integrity science? The proposal of this article is, that this is where the society's request for truths enters the discussion. A society that wishes a problem be solved, struggles with answers that start with 'may-be', 'it depends', 'confidence interval', 'trade-off' or 'negative exclusions'. Agenda-driven scientists who readily supply a 'consensus truth' may easily win the competition for resources against an offer with integrity that says it will not know for certain (for an example of claim of consensus, Nicholas Carter 2024, page 4, falsely describes the *EAT Lancet* publication by Willett *et al.* 2019 as 'a growing scientific consensus', https://www.thefreedomfoodalliance.org/report/home).

To showcase an example from nutrition: how much protein should a person eat per day? The real answer is, it depends. It depends on age, health status, gender, activity profile, personal genetic circumstances, other types of food being

eaten, environmental conditions and personal preferences. Moreover, the question is wrong. The real question is what bioavailable amino acid composition should be provided to a person per day, and the answer is that today's nutritionists know surprisingly little about this (IAEA 2023). Science can reasonably state that people should not eat less than 10% of their caloric intake from proteins, and not more than 35%. Everything in between, depends. However, this is not what non-science decision makers may want to hear in public or private. They may want to be told 'what is', and not 'what is not'. Scientists who are willing to fill the gap and give the decision makers the truth they seek may be seen as more relevant, and may be rewarded with more research funding to find even more of that truth. That becomes the point through which agenda-driven scientists make their entry. They willingly deliver a truth that the decision maker is asking for, which the integrity scientist is hesitant to provide due to better knowledge about the limits of knowledge. For instance, Marco Springmann from the third case study does not hesitate to propagate his truth that a vegan diet saves human lives and reduces the environmental burden of food production on the planet, and appears to have no qualms about manipulating the data in broad daylight in support of such evidently falsified statements. For his proclamation of truths, Springmann has been awarded by the World Health Organization with the design of the European 'Diet Impact Assessment Model, a tool for analysing the health, environmental and affordability implications of dietary change', which predictably recommends to reduce or eliminate livestock-derived foods from the human diet (WHO European Region 2023). The WHO commissioning of this model to Springmann may also answer the question to what extent the WHO is undermined by agenda-driven scientists in the first case study.

Conclusions

According to Karl Popper, to practice science to justify a theory to be true, is to 'beg for an authoritarian answer' (p. 51). With that he meant an answer that is considered right not because it is grounded in reality, but because it is held by a person with authority who can issue truths. He did not consider the latter to be a good circumstance, because it ultimately leads to authoritarianism and loss of freedom. According to Popper, the purpose of knowledge is not to justify a theory, but to attempt to falsify a theory. The stance that science takes between the two, will therefore ultimately either restrict (by justifying theories) or promote (by falsifying theories) freedom for all of society. Self-governing and free scientific research is defined by the Ministerial Conference of the European Research Area as the hall mark of open, pluralistic, free and non-authoritarian society, as follows: 'Research and the freedom to conduct research are indispensable prerequisites for our social, cultural, political and economic resilience and progress' (EU2020.de 2020, p. 2). According to notes by one of his students, the 19th century German philosopher Friedrich Hegel was once confronted with the following question by a student: 'but Professor Hegel, your theory does not agree with the facts', on which Hegel is said to have replied: 'that is too bad for the facts' (in German: 'Um so schlimmer für die Tatsachen'). Karl Popper characterised Friedrich Hegel as 'the father of modern historicism and totalitarianism' (Brooks 2021, section 1.1). Hegel knew the truth, where Popperians know the evidence.

Animal-related sciences are threatened by agenda-driven scientists. The third case study described above on the proceedings in the United Nations Food System Summit is a likely example of this. The agenda-driven contributors of AT2 stakeholders supplied their scientific-looking C-paper with 53 references, most of which are not related to the statements in the text, as outlined above. The form of scientific practice was kept, the integrity was not. Similarly, on the surface, Springmann *et al.* (2016, 2018) did everything right, including publishing their articles in the highest echelons of peer-reviewed journals and declaring their potential interests. The form of scientific practice was kept, the integrity of the interpretation was not. That airplane will not land. With regard to the IARC Working Group members or the GBD 2019 collaborators from the first two case studies, the reason for the resultant false science is unclear; whether it is insufficient rigour and reproducibility, conflict of interest, white hat bias or missionary zeal, time will tell.

This article proposes as a guide for scientists in any discipline related to animals, from nutrition to climate, and everything in between, to take not only the word, but also the entire concept of 'scientific truth' away from the mental toolkit. Popper would suggest that in the animal-related science disciplines, there are no truths about reality that an earnest scientist should hope to achieve. What can be hoped for is to use scientific evidence to narrow down the corridor, the confidence interval, of what is not the reality (the protein example above), or in the words of National Academies of Sciences, Engineering, and Medicine (2019), p. 30, 'to refine the degrees of confidence, rather than complete certainty'. Over time, this will safeguard the reputation and credibility of the animal-related scientists in society. It will make them fulfil their role to manage animals in modern society on the foundations of what is solidly known AND not known about physical, biological, chemical, social, economic and ethical conditions. With that search for scientific evidence, such integrity scientists will make their contribution to a free society that inhibits authoritarian attempts to force changes that citizens do not approve of. The airplanes of this kind of science will land.

Voices that are claiming scientific consensus to be on their side that the number of farmed animals and, concurrently, the amounts of animal-sourced foods must be radically reduced or even eliminated are becoming more frequent. These voices risk being caught out as cargo cult scientists. As a response

to these false claims of consensus, the co-authors of the Animal Frontiers April 2023 Special Issue launched the Dublin Declaration of Scientists on the Societal Role of Livestock in October 2022 (Dublin Declaration 2023; Leroy and Ederer 2023; Ederer and Leroy 2023). By early 2024, it has been signed by more than 1200 scientists around the world and remains open for signatures (www.dublin-declaration.org). It was conceived in the spirit of integrity science. Its first paragraph states that 'it aims to give voice to the many scientists around the world who research diligently, honestly and successfully in the various disciplines in order to achieve a balanced view of the future of animal agriculture'. The words 'truth' or 'true' do not appear in the Dublin Declaration.

Supplementary material

Supplementary material is available online.

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Data availability. The Supplementary material supplies analyses and data conducted in reference to the case study on the UN Food Systems Summit 2021.

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