UN environment programme

CBD/CP/RA/AHTEG/2025/1/INF/1

Distr.: General
26 June 2025

English only

Convention on Biological Diversity

Ad Hoc Technical Expert Group on Risk Assessment
Montreal, Canada, 8–11 July 2025
Item 3 of the provisional agenda*
List of prioritized topics for which further guidance materials on risk assessment may be needed

Synthesis of submissions of information on risk assessment and the discussions of the Open-Ended Online on Risk Assessment and Risk Management**

Note by the Secretariat

I. Introduction

1. In annex I to decision CP-9/13, the Conference of the Parties serving as the meeting of the Parties to the Cartagena Protocol on Biosafety established a process for the identification and prioritization of specific issues of risk assessment of living modified organisms that may warrant consideration with a view to developing further guidance. At its eleventh meeting, in decision CP-11/7, the Conference of the Parties serving as the meeting of the Parties to the Cartagena Protocol on Biosafety invited Parties to submit information on their needs and priorities for further guidance materials on specific topics of risk assessment of living modified organisms, including a rationale following the criteria set out in the aforementioned annex I to decision CP-9/13.

2. In response to this request, the Secretariat issued notification No. 2025-017, inviting Parties to the Cartagena Protocol on Biosafety to submit information in relation to their needs and priorities for further guidance on specific topics of risk assessment of living modified organisms, including a rationale following the criteria set out in annex I to decision CP-9/13. To facilitate the collection of information, the Secretariat developed a template for the submissions of information, which can be found in the annex to this present document.

3. In total, 12 submissions were received from Brazil, Chad, Colombia, Egypt, Malaysia, Mauritania, Mexico, the Niger, Pakistan, Panama, Peru and South Africa.

4. From the submissions, the following 15 topics were identified as issues or priority areas:[1]

(a) Detection and monitoring of living modified organisms;

(b) Genome-edited mammals for use in agriculture;

* CBD/CP/RA/AHTEG/2025/1/1.
** The present document is being issued without formal editing.
[1] Organized alphabetically.

(c) Living modified algae;

(d) Living modified animals;

(e) Living modified fish;

(f) Living modified microorganisms;

(g) Living modified organisms containing stacked events;

(h) Living modified organisms expressing genome editing machinery for pest or pathogen control;

(i) Living modified organisms for food, feed and processing;

(j) Living modified organisms produced through new biotechnologies;

(k) Long-term and cumulative effects of genetic constructs and living modified organisms;

(l) Operationalizing protection goals into relevant assessment and measurement end points;

(m) Simplified procedures (Article 13 of the Protocol) and agreements and arrangements (Article 14);

(n) Transportability of data for risk assessment of living modified organisms;

(o) Use of living modified organisms in centres of origin and in traditional agricultural systems.

5. In addition, three Parties indicated that there was a need for further capacity building on the topic of the risk assessment of living modified organisms.

6. The original submissions were made available on the Biosafety Clearing-House.

7. To further collect information related to the submissions by Parties, the Secretariat convened the Open-Ended Online Forum on Risk Assessment and Risk Management[2] from 21 April to 9 May 2025. The online forum was moderated by Ana Laura Mello from Uruguay and Anita Anthonysamy from Malaysia.

8. The discussions were organized around each of the submitted topics by Parties, with five topics being discussed over a period of seven days and having three sessions during the course of the online forum. A total of 282 interventions were made, of which 158 were from 24 Parties, 14 were from one Non-Party State, 105 were made from 18 organizations and 5 were made from one representative of indigenous peoples and local communities.

9. This document provides a synthesis of the information provided by Parties in their submissions and the information shared through the online forum. The following sections describe the aforementioned topics in more detail and are presented in alphabetical order. The references shared during the submission process and online forum can be found within CBD/CP/RA/AHTEG/2025/1/INF/2.

II. Detection and monitoring of living modified organisms

10. Two Parties indicated that detection and monitoring of living modified organisms to be priorities topics of risk assessment.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

11. The submitting Parties indicated that detection and monitoring of living modified organisms was crucial for ensuring implementation and compliance with the provisions of the Cartagena Protocol, in particular Article 15 and annex III.

[2] Available at: https://bch.cbd.int/en/portals/risk-assessment/forum.

12. In their submissions, it was further noted that detection and monitoring would be important to identify the occurrence of adverse effects resulting from the use of living modified organism, which may not have been anticipated during the risk assessment process, and to assess whether the conclusions from the risk assessment could be considered to be robust. Detection and identification of living modified organisms was also highlighted as being important for biosafety governance and risk management.

13. During the online discussions, it was noted that the issue of detection, identification, monitoring and traceability of living modified organisms would be dependent on national priorities and circumstances.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

14. The following challenges were raised in related to detection and monitoring in relation to existing risk assessment frameworks, guidance and methodologies:

(a) Existing laboratory infrastructure and capacity;

(b) Standardized protocols for environmental monitoring and surveillance;

(c) Available information;

(d) Regulatory systems;

(e) Newly developed living modified organisms and organisms produced through new biotechnologies.

15. During discussions of the online forum, it was noted that existing technical guidance would be sufficient and that the main challenge relates more specifically to the need for further capacity-building and development (particularly in resource limited settings), financing and the establishment of networks of laboratories.

16. There were diverging views of the participants of the online forum regarding the need to detect and identify organisms produced through genome editing, in particular those that contain small additions, deletions or base pair changes. It was noted that mixed regulatory approaches, in particular for those organisms produced through genome editing, may cause unintentional transboundary movements depending on how the countries regulate such organisms, which may also cause challenges for the advance informed procedure.

17. There was also a view that this topic could be considered to be broad in nature. Thus, it might be challenging to provide effective technical advice unless a particular living modified organism or specific methodologies for detection were defined.

18. The programme of work on detection and identification of living modified organisms, including the recent decision CP-11/8, was further noted as relevant to this topic. Some participants of the online forum emphasized the need to not duplicate work. There was also a suggestion to reinvigorate the programme of work on Handling, transport, packaging and identification (Article 18 of the Protocol), focusing on traceability through the use of documentation and an efficient utilization of molecular techniques.

C. Challenges in addressing the specific issue

19. The particular challenges for the detection and monitoring of living modified organisms may relate to:

(a) Existing laboratory infrastructure and capacity:

(i) Lack of access to reagents, equipment and reference materials, in particular for developing countries (e.g. cost, availability);

(ii) Limited capacity to detect single gene and multiple gene events;

(iii) Limited capacity to distinguish between single transformation events and stacked events;

(iv) Limited technical expertise in applying advanced methodologies, such as digital polymerase chain reaction and next-generation sequencing, to the detection and analysis of living modified organisms;

(v) Limited capacity at ports-of-entry;

(vi) Lack of accreditation of national laboratories;

(b) Standardized protocols for environmental monitoring and surveillance:

(i) Lack of guidance on how to integrate genomics, transcriptomics, proteomics, epigenomics and metabolomics into detection and monitoring of living modified organisms;

(ii) Lack of adaptation of new analytical techniques for detecting and identifying living modified organisms;

(iii) Detection of living modified organisms in processed products or in trace amounts is challenging;

(c) Available information:

(i) Information may not be available for unregulated or undocumented living modified organisms;

(ii) Information on living modified organisms may not be readily available;

(d) Regulatory systems:

(i) Lack of systematic monitoring mechanisms for measuring persistence and unintended effects of living modified organisms;

(ii) Lack of regulation to enable detection and monitoring activities;

(iii) Risk assessment regulatory frameworks focus more on pre-release rather than post-release of a living modified organism;

(iv) Limited experience with labelling and documentation for some Parties;

(e) Newly developed living modified organisms and organisms produced through new biotechnologies:

(i) Existing experience relates to living modified crop plants with simple traits rather than the variety of organisms (e.g. animals, microorganisms, algae) that have been produced to date;

(ii) Technical challenges may exist for distinguishing all living modified organisms and organisms produced through genome editing;

(iii) Challenges in distinguishing varieties developed using new genomic techniques from conventionally bred varieties (e.g. cisgenic varieties, genome-edited organisms);

(iv) New and validated tools for detecting, identifying and monitoring might be required for detecting newly developed living modified organisms and organisms produced through genome-editing.

20. During the online discussions, it was suggested that these specific challenges may be more acute in megadiverse countries. However, traditional ecological knowledge was suggested as supporting the understanding of the environment for monitoring.

21. Further, it was indicated that rapid, easily deployable detection methodologies that meet the same performance standards as the current tools available for living modified organisms may not be technically feasible for organisms produced through genome-editing that contain small genomic changes (e.g. small base pair changes). Thus, it was noted that scalable solutions for routine use have yet to be developed.

D. Specific issues concerning detection and monitoring of living modified organisms

1. Potential to cause adverse effects on biodiversity

22. Regarding the potential adverse effects on biodiversity, it was indicated that these would be specific to the living modified organism of interest. However, the following potential adverse impacts on biodiversity were mentioned in relation to undetected living modified organisms:

(a) Adverse impacts on non-target organisms;

(b) Adverse impacts on food webs;

(c) Threaten pollinators, rare and endemic species;

(d) Reduction of genetic diversity, in particular for centre of origin.

23. It was also noted that the topic may have important considerations for indigenous peoples and local communities, as well as for women. For example, insufficient monitoring could lead to unintentional seed preservation and use small-scale, local agriculture.

2. Introduction into the environment

24. In general, it was mentioned that living modified organisms can be introduced into the environment accidentally or deliberately. During the discussions of the online forum, it was noted that introgression of transgenes into native varieties of maize has been reported in Mexico.

3. Dissemination across national borders

25. In general, the dissemination across national borders would relate to the living modified organisms itself and its designated use. For example, living modified microorganisms may spread naturally in the environment or have their movement facilitated naturally and by humans, while living modified crops are likely to be traded internationally.

26. The importance of detecting transboundary movements was also mentioned. It was suggested that the movement of living modified organisms can be exacerbated due to porous borders, informal trade or insufficient screening activities.

4. Commercialization status of living modified organisms

27. Many living modified organisms have received regulatory approval, including living modified soyabean, maize, cotton and papayas. They may also be more prevalent in some jurisdictions compared to others. It was also noted that organisms produced through genome editing are starting to be commercially available and there are many research projects investigating various types of genome-edited organisms.

E. Existing resources on similar issues

28. *Biosafety Technical Series 05: Training Manual on the Detection and Identification of Living Modified Organisms in the Context of the Cartagena Protocol on Biosafety*[3] published by the Secretariat of the Convention on Biological Diversity, the voluntary *Guidance on Risk Assessment of Living Modified Organisms*[4] published by the Secretariat, the *Laboratory Biosafety Manual*[5]

[3] Available at: https://bch.cbd.int/en/database/VLR/BCH-VLR-SCBD-260177-3.
[4] UNEP/CBD/BS/COP-MOP/8/8/Add.1, Part III *Monitoring of living modified organisms released in the environment*
[5] Laboratory biosafety manual, fourth edition. Geneva: World Health Organization; 2020 (Laboratory biosafety manual, fourth edition and associated monographs).

published by the World Health Organization, the Biosafety Clearing-House, the BioTrack Product Database, GMOMETHODS database[6], European GMO Initiative for a Unified Database System[7], the Detection Methods database[8] and the Global Biolabs Database[9] were shared as being important and existing technical resources. In addition, the Network of Laboratories for the Detection and Identification of Living Modified Organisms was noted as supporting the work on detection and identification of living modified organisms.

29. Regarding Biosafety Technical Series 05, it was suggested that the publication could be complemented or updated with new information on the latest tools and methodologies, such as digital polymerase chain reaction and next-generation sequencing. Another proposal related to identifying and developing complementary resources to this publication.

30. Two research projects, DARWIN[10] and DETECTIVE,[11] funded by the European Union exploring the detection and identification of organisms produced through new genomic techniques were also shared during the online forum.

31. There was a view that section 6 of the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives*[12] would be an example of how detection and monitoring could be address as a component of a broader topic. However, it could also be noted that current risk assessment guidance often does not include specific technical information regarding the detection and monitoring of living modified organisms in the environment and currently, there are no guidelines for the environmental monitoring of genome-edited organisms.

III. Genome-edited mammals for use in agriculture

32. One Party identified genome-edited mammals for use in agriculture as a priority topic for risk assessment. Genome-edited mammals are those that have been modified using genome-editing techniques to introduce deletions, insertions and base pair changes into the host genome.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

33. In their submission, the Party suggested that genome-edited mammals for use in agriculture may have considerations for the conservation and sustainable use of biological diversity due to their introduction to the environment. Thus, such applications could be considered to be within the scope of the Protocol.

34. During the online discussions, there were diverging views on whether genome-edited mammals would be considered to fall within the scope of the Protocol based on the definition of "living modified organism".

B. Challenges to existing risk assessment frameworks, guidance and methodologies

35. Several participants of the online forum noted that guidelines that are generally available for the living modified animals and other types of living modified organisms would be generally applicable to genome-edited organisms. In particular, there was a view that conducting case-by-case risk assessment in line with Annex III to the Protocol and using a problem formulation approach would be sufficiently flexible to address the risk assessment of genome-edited mammals for use in agriculture.

[6] Available at: https://gmo-crl.jrc.ec.europa.eu/gmomethods/.
[7] Available at: https://euginius.eu/euginius/pages/home.jsf.
[8] Available at: https://detection-methods.com/.
[9] Available at: https://www.globalbiolabs.org/.
[10] Available at: https://darwin-ngt.eu/.
[11] Available at: https://detective-ngt.eu/.
[12] CBD/CP/MOP/11/9.

36. There were also views that there could be specific or technical challenges that may require additional consideration, including:

(a) The genetic modification;

(b) Experience;

(c) Interactions with the environment;

(d) Mobility;

(e) Detection, monitoring and traceability;

(f) Animal welfare.

37. Regulatory ambiguity was also raised as a concern during the online forum and was noted as having the potential to create different perspectives and lead to various risk assessment methodologies being applied among Parties to the Protocol.

38. Some participants also suggested that there is a lack of guidelines to address the risk assessment of genome-edited mammals despite the increased interest in developing genome-edited mammals for use in agriculture. However, other participants suggested that experience sharing, further capacity-building and international cooperation would be sufficient for addressing the challenges.

C. Challenges in addressing the specific issue

39. Regarding the specific challenges to risk assessment of genome-edited mammals for use in agriculture, the following potential challenges were identified:

(a) Related to the genetic modification:

(i) Unintended (on-target or off-target) outcomes of the genome editing process are difficult to predict (e.g. mutations in other genomic regions, integration of plasmid backbone sequences, potential creation of unforeseen or novel end-products, genomic instability, mutations induced by cloning);

(ii) Genetic mosaicism could lead to variable outcomes and lack uniformity within the organism;

(iii) Genomic edits may cause pleiotropic affects, which may not be well understood;

(iv) Novel traits may have phenotypes that are complex to assess;

(b) Related to experience:

(i) Limited understanding of and experience with genome-edited mammals and how to assess their potential direct or indirect risks;

(ii) Assessing multiplexed genomic edits can be complicated (e.g. potential for synergistic effects and unexpected outcomes);

(iii) Limited experience with the risk assessment of animals (e.g. most risk assessment experience comes from the assessment of living modified crop plants, modified mammals have a greater potential for various genomic, epigenomic, proteomic and metabolomic effects);

(c) Related to interactions with the environment:

(i) Challenges exist for understanding and predicting pathogen evolution, pathogen emergence and the potential for spillover events (in the case of mammals genomically edited for disease resistance);

(ii) Gaps in knowledge related to cumulative and combinatorial effects;

(iii) Environmental influences on phenotypes may be unpredictable for the introduced genomic edition;

(d) Related to mobility:

(i) Mammals have an increased potential for movement (e.g. escape, transboundary movements);

(e) Related to detection, monitoring and traceability:

(i) Genome edits may be indistinguishable from a naturally occurring mutations using current analytical techniques;

(ii) Small mutations may be technically difficult to detect;

(iii) Lack of guidance on unbiased 'omics' profiling and detailed long-read sequencing for detecting unintended effects;

(iv) Less experience in applying more sensitive analytical tools for the detection and monitoring of genome-edited mammals;

(v) Lack of standardized methodologies for detecting unintended effects resulting from the use of genome editing;

(vi) Lack of infrastructure in developing countries to conduct detection and monitoring activities;

(vii) Need to monitoring potential pathogen evolution (in the case of disease-resistant genome-edited mammals);

(f) Related to animal welfare:

(i) Inability to predict adverse impacts on mammals being modified (e.g. deformities, still births, miscarriages, early animal death, immune dysregulation).

40. It was suggested that the instability resulting from genome editing observed in plants would likely be observed in mammals too. Thus, these unintended effects may be difficult or complex to predict when conducting a risk assessment.

41. Further, some participants of the online forum suggested that specifically for that disease resistant genome-edited mammals, there could be a selective pressure on the viral pathogen to evolve. It was mentioned that viral evolution would be difficult to fully predict prior to the release of a genome-edited mammal and is a consideration not generally addressed during the risk assessment of living modified crops. The example of unintended adaptive evolution of avian influenza that was observed during the development of disease-resistant living modified chickens was shared.

D. Specific issues concerning genome-edited mammals for agricultural use

1. Potential to cause adverse effects on biodiversity

42. Regarding the potential adverse effects, the following were suggested:

(a) Adverse effects to biodiversity:

(i) Ecosystem disruption if genome-edited animals outcompete native relatives;

(ii) Reduced genetic diversity if genome-edited breeds are relied upon instead of traditional breeds or breeding occurs with traditional breeds;

(iii) Increased burden on water resources if genome-edited mammals are highly utilized;

(b) Adverse effects to human and animal health:

(i) Creation or expression of novel toxins or allergens;

(ii) Selective pressure on viral pathogens or unintended viral evolution could lead to potential spill-over events into wild populations (if mammals were edited for disease resistance) or the creation of pathogen reservoirs;

(iii) Immune dysregulation in animals being genomically edited;

(c) Adverse impacts on animal welfare:

(i) Techniques used to create genome-edited mammals requires the use of reproductive techniques that can result in adverse effects such as mosaicism, developmental defects, miscarriages and early death;

(ii) Increased stress due to higher performance rate and pressure, or due to use of mass rearing conditions.

43. During the online discussions, it was raised that many indigenous peoples and local communities rely on traditional breeds, which hold culture significance. Unexpected impacts, such as a virus evolving to be more virulent, could disproportionately impact indigenous peoples and local communities should the virus cause adverse impacts to the traditional breeds. Furthermore, indigenous people and local communities may also be impacted by scarcity if production shifts away from traditional protein sources.

2. Introduction into the environment

44. Introduction into the environment will be related to the production system being utilized. It is expected that genome-edited mammals will be released into managed environments, such as farms, or in open systems, such as for grazing purposes. Genome-edited mammals may also accidentally escape confined conditions, which could potentially lead to feral populations.

45. Due to regulatory ambiguity, it was suggested that there could be an increased potential to have unintentional introduction of genome-edited mammals into the environment depending on the jurisdiction.

3. Dissemination across national borders

46. For genome-edited mammals, it is likely that transboundary movement will be facilitated through importation and exportation, including germplasm. However, since mammals for agricultural use are mobile, they could potentially cross-national borders themselves. Informal trading and movement may also facilitate movement of genome-edited mammals.

47. It was noted that differences in regulatory approaches may lead to unintentional transboundary movements.

4. Commercialization status of the genome-edited mammals for agricultural use

48. Several examples of genome-edited mammals that have been approved or are currently undergoing regulatory approval were shared, including pigs resistant to Porcine reproductive and respiratory syndrome virus, hornless cattle, heat-tolerant cows and cows with increased muscle mass.

49. It was also highlighted that research is increasing with respect to the application of genome editing tools to ruminants and monogastric animals. The most common traits were for increased yield, improved reproduction and disease resistance.

E. Existing resources on similar issues

50. At time of submission, the Party did not find any specific materials to support the risk assessment of genome-edited mammals for use in agriculture.

51. During the online discussions, it was suggested the existing guidance documents for living modified organisms and living modified animals would be sufficient for conducting risk assessment of genome-edited mammals for use in agriculture, such the *Guidance on the environmental risk*

assessment of genetically modified animals by the European Food Safety Authority[13] and the *Roadmap for Risk Assessment*[14]. However, other participants noted that existing guidance materials on risk assessment do not account for the specific challenges related to the genome-editing of mammals used in agriculture.

IV. Living modified algae

52. One Party identified living modified algae as a specific topic for risk assessment. In their submission, the Party specified that a particular focus was those living modified algae that are intended for environmental release or large-scale cultivation.

53. Living modified algae are being developed for the production of biofuels and biopharmaceuticals, as well as for bioremediation purposes, food production and bio-control applications. There could also be applications for climate change mitigation due to their ability to efficiently sequester carbon.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

54. It was noted that living modified algae are relevant to the Protocol since they are living modified organisms and may have the potential to cause impacts on ecosystems and biodiversity.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

55. The submitting Party and some participants of the online forum noted that existing risk assessment frameworks, guidance and methodologies may not fully address the unique characteristics of living modified algae. The main challenges posed by living modified algae were suggested to be related to:

(a) Algal biology;

(b) Algal ecology;

(c) Aquatic environments;

(d) Detection and monitoring;

(e) Risk management and containment;

(f) Risk management.

56. There was a view that current experience and scientific knowledge on algae may further lead to difficulties for assessors to evaluate the potential risks. Some participants of the online forum suggested existing resources and frameworks for risk assessment of living modified organisms were designed for terrestrial organisms, rather than aquatic ones. Thus, there might be a lack of regulatory and methodological experience regarding the risk assessment of living modified algae.

57. It was noted that most research has focused on laboratory or contained settings and not large-scale ecological studies on such applications in the open environment. Thus, there might be a lack of baseline data to predict how living modified algae will interact within the environment and spread within the environment.

58. It was also emphasized that risk assessment should follow a case-by-case basis and thus will relate to the type of system utilized, whether it is a closed, contained system or open cultivation (non-contained water body). Similarly, the intended use and specific application of living modified algae (e.g. for biofuel production, for biopharmaceutical applications, for bioremediation purposes) will also influence the risk assessment and potential risks.

[13] European Food Safety Authority Panel on Genetically Modified Organisms (2013) Guidance on the environmental risk assessment of genetically modified animals. *EFSA Journal*. vol. 11, 5.
[14] Part I of UNEP/CBD/BS/COP-MOP/6/13/Add.1.

59. Some of the participants of the online forum also suggested that the challenges highlighted for living modified algae could be addressed by Annex III to the Protocol and defining clear pathways to harm as a way to focus information gathering to support the risk assessment processes. In addition, there was a view that challenges posed by living modified algae to risk assessment could also be addressed by improving the capacity of risk assessors to formulate adequate risk scenarios.

C. Challenges in addressing the specific issue

60. The following specific challenges related to the risk assessment of living modified algae may relate to:

(a) Algal biology:

(i) Great diversity among species of algae (e.g. cellular biology, reproductive mechanisms, metabolism, adaptability);

(ii) Microscopic size;

(iii) Rapid reproduction rates;

(iv) Mobility;

(v) Potential for horizontal gene transfer;

(b) Algal ecology:

(i) Potential for wide dispersal in aquatic environments;

(ii) Limited baseline data on algal populations, their ecological role, their ecological interactions and their behaviour;

(iii) Difficulty predicting long-term persistence and evolution;

(iv) Challenges in assessing ecological interactions;

(v) Ecological adaptability leading to varied behaviours in different environments;

(vi) Lack of standardized data on long-term ecological interactions specific to living modified algae;

(c) Aquatic environments:

(i) Lack of baseline data on aquatic ecosystems;

(ii) Inherent complexity and variability of aquatic ecosystems;

(iii) Difficulty predicting ecological consequences of horizontal gene transfer due to a high likelihood for many interactions within aquatic environments;

(d) Detection and monitoring:

(i) Lack of standardized methods and tools for detecting and monitoring living modified algae in aquatic environments;

(ii) Gene flow to other strains or species could complicate detection and monitoring;

(iii) Potential for widespread dispersal may make large-scale monitoring complicated, particularly for transboundary dispersal;

(iv) Small size of some species of algae may make detection and monitoring more difficult;

(e) Risk management and containment:

(i) The potential for large-scale dispersion following release would complicate potential containment and risk management measures;

(ii) Lack of developed emergency and risk management measures;

(iii) Irreversibility of release.

61. During discussions of the online forum, it was also stressed that the considerations above should be evaluated on a case-by-case basis.

62. There was also a view that due to the potential for large spatial distributions, there might be a need for international cooperation to address the potential challenges.

D. Specific issues concerning living modified algae

1. Potential to cause adverse effects on biodiversity

63. Regarding the potential adverse effects on biodiversity, it was suggested that living modified algae could:

(a) Be invasive and outcompete native species, leading to changes in community structures, disruption of trophic levels or local extinction events;

(b) Disrupt food webs by altering primary production within an ecosystem through the swift accumulation of biomass and rapid reproduction (e.g. hazardous algal blooms);

(c) Exacerbate or create dead zones (e.g. hypoxia amplification due to accelerated biomass decay following algal blooms);

(d) Reduce ecosystem resilience through horizontal gene transfer;

(e) Alter water quality and contaminate drinking water, especially for developing countries or indigenous peoples and local communities that rely on natural water bodies;

(f) Production of toxic compounds, which could have adverse effects on non-target organisms or on human health.

64. It was however noted that the potential adverse effects would depend on the specific case of use of a specific living modified algae and in comparison with the non-modified counterpart.

65. In the case of cyanobacteria, these types of algae could have a higher potential for horizontal gene transfer due to their natural competence. Depending on the nature and trait of the genetic elements transferred, this could lead to a higher potential for adverse effects.

66. It was suggested that the aquatic resources of indigenous peoples and local communities, as well as those of coastal and island fishing communities, could be impacted should adverse impacts be realized from the release of living modified algae. In addition, algae could be considered to be an important resource and may hold particular value for indigenous peoples and local communities.

67. During the online discussions, it was also noted that the microalgae strains used in biotechnological applications often require optimized cultivation conditions, which would potentially limit their ability to establish in natural environments and thus reduce the potential for adverse effects.

68. Regarding risk management, there was a view that synthetic auxotrophy, CO_2-concentrating mechanism knockout and toxin-inducible lethal switches show promise for biocontainment. However, these strategies have yet to be validated under ecologically realistic conditions and peer-reviewed trials. Given the state of development and the perceived challenges associated with the environmental release of living modified algae, the precautionary principle was emphasized by some of the participants and a stepwise approach was suggested with respect to environmental release.

2. Introduction into the environment

69. Intentional introduction into the environment might be to produce biofuels, carbon sequestration or bioremediation. However, it was also noted that living modified algal applications will likely be for contained use.

70. Accidental release into the environment may occur during cultivation or transportation (e.g. industrial spills or laboratory leaks), or though natural disasters (e.g. flooding, extreme weather). Unintended release may potentially lead to spread of living modified algae in natural environments.

3. Dissemination across national borders

71. Due to their microscopic size and the natural buoyancy of many algal species, these organisms have an increased likelihood of dispersal across wide geographical areas and across national boundaries. Natural bodies of water, such as lakes and rivers, can also cross-national borders.

72. Beyond dissemination in water (e.g. rivers, ocean currents), wind, wildlife and human activities (e.g. ship ballast water) could also facilitate the movement of living modified algae across national borders.

4. Commercialization status of living modified algae

73. At the time of submissions by Parties, large-scale applications of living modified algae were limited. But the submitting Party noted an increased interest in scaling up applications of living modified algae related to the biotechnological and energy sector, which could suggest environmental releases of living modified algae in the near future.

74. During the online discussions, participants also noted that large scale applications were rare. However, applications for biofuels (Synthetic Genomics), nutraceuticals (DSM) and carbon capture (Brilliant Planet) were advancing and potentially reaching small pilot trials.

75. Some participants also suggested that there was a high potential for commercialization given the increased research on living modified algae, particularly for lipid bioproduction for biofuel uses. An example shared during the online discussions included research on the microalgal species *Picochlorum renovo* due to its high growth rate and high thermal tolerance. It was mentioned that future applications may be focused on redesigning algal systems using artificial intelligence.

E. Existing resources on similar issues

76. No specific guidance documents for living modified algae were highlighted in the submissions by Parties or during the discussions of the online forum.

77. The risk assessment of the living modified *Nannochloropsis oceanica* published by the Office of the Gene Technology Regulator of Australia was highlighted as an important reference as it provided several plausible pathways to harm.[15] Further, several scientific publications were also shared on the topic of risk assessment and biocontainment of living modified algae, noting that the formulation for risk scenarios for living modified algae would be similar to those for living modified crop plants. Reports on algae and their use in biotechnology from the Commission on Genetic Modified Modification of the Kingdom of the Netherlands were also shared.[16]

78. The submitting Party and some participants of the online forum noted that general guidance documents on risk assessment have been produced by the Secretariat of the Convention on Biological Diversity, the Organisation for Economic Co-operation and Development, and International Risk Governance Council. However, it was suggested that these resources may require adaption to address the specific characteristics and risks associated with living modified algae, particularly in aquatic environments. Similarly, the documents from the Organisation for Economic Co-operation and

[15] Office of the Gene Technology Regulator. DIR 169 – Risk Assessment and Risk Management Plan: Commercial release of genetically modified *Nannochloropsis oceanica* for production of omega-3 long chain polyunsaturated fatty acids.

[16] Van Rooij and others (2021) Taxonomy and risk classification of algae: Informing risk classification of a dynamic taxonomic group. Commission on Genetic Modification. Report CGM 2021-01.
Smets and others (2022) Establishment and proliferation potential of cyanobacteria: Properties that can inform the risk assessment. Commission on Genetic Modification. Report CGM 2022-03.

Development[17] and International Council for the Exploration of the Sea[18] could also provide relevant information.

79. There was also a view that Annex III to the Protocol provides a sound methodology for the case-by-case evaluation of any living modified organism and thus allows for the determination of relevant considerations (e.g. biological characteristics of each organism, genetic modification, and proposed cultivation system) in line with national contexts. Furthermore, it was suggested by some participants that the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives*[19] provides a robust and flexible framework for framing and informing case-by-case risk assessments any living modified organism, including algae.

80. Some participants also suggested that any developed guidance could incorporate case-specific aquatic models and embed participatory approaches. It was additionally suggested that any developed guidelines could focus on the release or commercial production of algae in unconfined environments. However, the diverse range of organisms considered as "algae" was suggested as potentially complicating the development of single guideline or guidance document.

V. Living modified animals

81. One Party identified living modified animals as a priority topic of risk assessment.

82. Living modified animals can refer to vertebrates (e.g. farm animals, fish) or invertebrates (e.g. mosquitoes). Mammals are often modified for disease resistance, growth enhancement or abiotic stress tolerance, while insects are modified for pest control applications.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

83. It was noted that living modified animals would be covered under the scope of the Protocol.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

84. The submitting Party and some participants of the online forum noted that the challenges to current risk assessment frameworks, guidance and methodologies posed by living modified animals relate to:

(a) Animal behaviour;

(b) The genetic modification;

(c) The receiving environment;

(d) Monitoring.

85. During the discussions of the online forum, some participants mentioned that current risk assessment frameworks and protocols have been designed for living modified plants. Thus, they may not take into account living modified animals or their unique characteristics. Moreover, experience might be limited for the risk assessment of living modified animals. It was also highlighted that many countries lack clear regulation and regional harmonization of approaches for living modified animals.

86. There was also a view that a case-by-case, evidence-based and scientific approach, such as following the Annex III to the Protocol, would be sufficiently flexible to address the risk assessment of living modified animals. Furthermore, it was also suggested that strengthening technical expertise in the area of risk assessment of living modified organisms in general could also address the potential

[17] Organisation for Economic Co-operation and Development (2015) Biosafety and the Environmental Uses of Micro-Organisms: Conference Proceedings. OECD Publishing.
[18] International Council for the Exploration of the Sea (2005) ICES Code of Practice on the Introductions and Transfers of Marine Organisms 2005.
[19] CBD/CP/MOP/11/9.

challenges associated with living modified animals. However, it was unclear to some participants how issues of animal welfare would be accounted for in an environmental risk assessment, if at all.

C. Challenges in addressing the specific issue

87. Living modified animals may potentially present the following specific challenges:

(a) Related to animal behaviour:

(i) Mobility of living modified animals allows for migration, increasing the number of interactions with multiple species (e.g. particularly for birds and insects);

(ii) Breeding behaviours and reproductive mechanisms vary greatly between animal species;

(b) Related to the genetic modification:

(i) Limited data on how genetic modifications impact animal welfare;

(ii) Limited ability to predict how gene flow might impact fitness or cause adverse impacts on wild populations;

(iii) Difficulty in identifying unintended epigenetic modifications and their potential consequences;

(iv) Predicting pathogen evolution and the potential for zoonotic spillover events (for disease resistant living modified animals);

(c) Related to the receiving environment:

(i) Lack of consolidated methodologies for predicting indirect impacts of living modified animals on population dynamics and food chains;

(ii) Lack of long-term ecological or socioeconomic data on the impacts on living modified animals;

(iii) Difficulty in predicting non-linear impacts of living modified animals on ecosystems, including invasiveness and displacement of native populations, impacts on food webs;

(iv) Unpredictable ecological interactions from disease resistance or reproductive manipulation;

(d) Related to monitoring:

(i) Challenges in monitoring pathogens (especially in asymptomatic living modified animals acting as pathogen reservoirs);

(ii) Lack of standardized methods for detecting unintended alterations (e.g. complex protocols, applicability across different cell types, associated costs, sensitivity, requirement of suitable controls, bias);

(iii) Need for robust ecological monitoring;

(iv) Transboundary nature of mobile living modified animals may challenge monitoring and co-operation.

88. The topic of living modified animals was additionally noted as being broad, potentially referring to various types of species. Thus, potential challenges and the availability of existing information would vary depending on the species modified.

D. Specific issues concerning living modified animals

1. Potential to cause adverse effects on biodiversity

89. Regarding the potential adverse effects of living modified animals on biodiversity, it was stressed that the particular animal species would ultimately influence the potential effects. However, given this, the following potential adverse effects were highlighted:

(a) Disruption of food webs (e.g. altered predator-prey dynamics);

(b) Invasiveness and displacement of native populations due to increased competitiveness;

(c) Introgression of modified genes or gene flow could affect the fitness of natural populations or spread antibiotic resistance genes;

(d) Unintended adverse effects on wild pollinators for applications targeting pollinators;

(e) Unintended allergenicity or toxicity to predators or humans;

(f) Human health complications (e.g. potential for zoonotic spillover from animals, potential spread of pathogens, safety of xenotransplants);

(g) Potential for evolution of pathogens in both animal and human populations in the case of disease resistant living modified animals (e.g. expanded host range, generation of pathogen reservoirs, ability to overcome available treatments);

(h) Niche replacement with secondary pests of pathogens (for applications targeting pests or disease vectors);

(i) Displacement of native species or breeds valued by or important for indigenous peoples and local communities;

(j) Birth, developmental or behavioural disorders in the host organism due to genetic modification;

(k) Genetic modifications could cause pain, distress or unintended health impacts (e.g. mosaicism, deformities, still births, miscarriages, shorter lifespan).

90. It was noted that animals may be significant for livelihoods or hold sacred value for indigenous peoples and local communities. Furthermore, it was noted that women often manage local breeds and could be disproportionately affected by changes in animal populations or access to traditional livestock. Unintended impacts may also threaten livelihoods of indigenous peoples and local communities.

91. Regarding animal welfare, it was noted by some participants that this could be considered to be an ethical consideration rather than an adverse impact on biological diversity.

2. Introduction into the environment

92. It was mentioned that animals could be introduced deliberately or accidentally into the environment. However, the mobility of living modified animals could increase the potential for unintended introduction into the environment. However, the exposure to the environment and the potential for release of the living modified animal will depend on the particular type of production system being utilized and the associated ecosystem (e.g. marine, fresh water, cultivated agricultural habitats, natural and semi-natural habitats, rural and urban areas), as well as the species being modified (e.g. if there is a dependency humans to thrive).

3. Dissemination across national borders

93. It was mentioned that many animals are naturally mobile (e.g. birds, insects, fish), which can cross national borders. It was also noted that potential transboundary movements could also vary depending on the species in question. For example, living modified insects may cross international boundaries and spread undetected, while higher order animals would be easier to detect.

4. Commercialization status of living modified animals

94. Regarding living modified insects, several self-limiting insect examples were shared, including a field trial of *Drosophila* (precision guided sterile insect technique; Agragene), a commercialized fall armyworm (Oxitec) and the development of self-limiting cattle tick (Oxitec).

95. Some examples of genome-edited mammals under regulatory review were also shared, including, heat-tolerant cattle, cattle with increased muscle mass and Porcine Reproductive Respiratory Syndrome-resistant pigs. Participants of the forum also highlighted the recent de-extinction of a dire wolf (*Canis dirus*) by Colossal Biosciences. However, it was suggested that the animal was rather a modified grey wolf (*Canis lupus*), whose genome contains 20 modifications to confer a longer coat and larger size.

96. The ongoing research on disease resistance in animals (e.g. modified chickens for avian influenza resistance) was also highlighted during the discussions of the online forum.

E. Existing resources on similar issues

97. The *Guidance on the environmental risk assessment of genetically modified animals*[20] published by the European Food Safety Authority Panel on Genetically Modified Organisms was mentioned as being an existing resource specific to living modified animals. The Integrated Vector Management Programme of the African Union Development Agency was also mentioned as having on-going work to develop resources to support risk assessment.

98. In the context of living modified mosquitoes, the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives*,[21] the *Study on risk assessment: application of annex I of decision CP-9/13 to living modified organisms containing engineered gene drives*,[22] the *Guidance framework for testing of genetically modified mosquitoes*[23] and *Guidelines for risk analysis for the testing and deployment of genetically modified mosquitoes*[24] were relevant existing resources that support the application of Annex III to the Protocol while using a problem formulation approach. It was further suggested that these could be applicable to other types of living modified animals more generally.

99. The biology documents for *Aedes egypti*[25] and Atlantic salmon (*Salmo salar*)[26] published by the Organisation for Economic Co-operation and Development were also raised as important existing resources.

100. Regarding existing resources that could be adapted, it was suggested that the resources produced by the Secretariat of the Convention on Biological Diversity, such as the voluntary *Guidance on Risk Assessment of Living Modified Organisms and Monitoring in the context of Risk Assessment*[27] and the Gender Plan of Action,[28] could be adapted or important resources to take into consideration.

101. Further, the work by the Organisation for Economic Co-operation and Development on novel traits in livestock was suggested as potentially providing some relevant insights. However, it was

[20] European Food Safety Authority Panel on Genetically Modified Organisms (2013) Guidance on the environmental risk assessment of genetically modified animals. *EFSA Journal*. vol. 11, 5.
[21] CBD/CP/MOP/11/9.
[22] CBD/CP/RA/AHTEG/2020/1/4.
[23] World Health Organisation (2021) Guidance Framework for Testing Genetically Modified Mosquitoes, second edition. Geneva.
[24] African Union Development Agency (2022) Guidelines for Risk Analysis for the Testing and Deployment of Genetically Modified Mosquitoes. AUDA-NEPAD, Midrand, South Africa.
[25] Organisation for Economic Co-operation and Development (2018) Consensus document on the biology of mosquito *Aedes aegypti*. Series on Harmonisation of Regulatory Oversight in Biotechnology. No. 65.
[26] Organisation for Economic Co-operation and Development (2017) Consensus document on the biology Atlantic salmon (*Salmo salar*). Series on Harmonisation of Regulatory Oversight in Biotechnology. No. 64.
[27] UNEP/CBD/BS/COP-MOP/8/8/Add.1.
[28] CBD/COP/DEC/14/18.

suggested that evolutionary ecology and gene flow modelling would be important considerations for inclusion into future guidance.

102. It was mentioned that the World Organisation for Animal Health establishes working codes for terrestrial and aquatic animals. Therefore, it was suggested that guidelines could be developed to take the specific aspects of terrestrial and aquatic animals into account. It was also suggested that any further guidance could consider animals for industrial use or on birds and mammals.

VI. Living modified fish

103. One Party identified living modified fish as a specific topic of risk assessment. The Party indicated that their interest to focus on fish species that have the potential to be invasive and are used in large aquaculture systems.

104. It was noted that living modified fish were being developed for food and ornamental purposes.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

105. In their submission, the Party specified that living modified fish could have the potential to cause adverse impacts on ecosystems and biodiversity. Thus, this topic could be considered to be within the scope of the Protocol.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

106. During the online discussions, there were diverging views on whether living modified fish posed challenges to risk assessment frameworks, guidance and methodologies. However, the submitting Party and some participants of the online forum noted the potential challenges posed by living modified fish might relate to:

(a) Fish biology;

(b) The genetic modification;

(c) Fish ecology;

(d) The aquatic receiving environment;

(e) Risk management;

(f) Detection and monitoring;

(g) Institutional arrangements.

107. Some participants of the online forum noted that Annex III to the Protocol provides a comprehensive and adaptable framework for the risk assessment of living modified fish. As such, it establishes principles of risk assessment that should address the particularities of living modified fish on a case-by-case basis, while considering specific characteristics related to living modified fish and the receiving environment. The example of Panama and the AquAdvantage salmon was provided in this respect. Similarly, some participants also suggested that a problem formulation approach, relying on pathways to harm, would also provide a robust framing for informing the case-by-case risk assessment of any living modified organism, including living modified fish.

108. Other participants noted however that current risk assessment frameworks were developed for terrestrial organisms and that most experience with environmental risk assessment of living modified organisms has been with living modified crop plants. Thus, there could be a lack of experience with the risk assessment of living modified fish.

109. It was also suggested that current risk assessments of living modified fish have been conducted in the Global North, which may underestimate environmental conditions in the Global South. This was suggested as potentially underestimating the potential adverse effects of living modified fish,

such as invasiveness. Thus, a stepwise approach (e.g. phased testing) was suggested as important by some participants during the online discussions.

110. It was also suggested that it might be important to understand better from the Parties that identified this topic as a need or priority what their reasons were to revisit the topic given the previous intersessional work on the topic. It might also be important to review and update any of the previous collected information or specify a species of fish. It was also mentioned that the *Study on risk assessment: Application of Annex I of decision CP-9/13 to living modified fish*[29] still contained information relevant for the challenges to risk assessment frameworks, guidance and methodologies.

111. There was a view that some of the considerations that would be important for other living modified aquatic organisms, such as algae and microorganisms, would also be applicable to the risk assessment of living modified fish. Thus, there might be a more general need for aquatic environment-specific methodologies.

C. Challenges in addressing the specific issue

112. Living modified fish may potentially present the following specific challenges:

(a) Related to fish biology:

(i) Mobility of fish could cause large spatial distributions and transboundary movements;

(ii) High reproductive rates;

(iii) High potential for pleiotropic effects;

(b) Related to the genetic modification:

(i) Potential for gene flow and its ecosystem consequences is complicated to predict;

(ii) The potential for genetic mosaicism and genetic variants may mean that unintended effects are difficult to predict (e.g. impacts on behaviour, physiology);

(iii) The impact of the genetic elements may be difficult to predict (e.g. on behaviour, fitness in comparison to the non-modified fish in the receiving environment);

(iv) Uncertainty surrounding stability of the modification (e.g. induced sterility, mosaicism);

(v) Fish are sensitive to genotype-environment interactions;

(c) Related to fish ecology:

(i) High potential to become invasive, which may not be sufficiently addressed by current risk assessment frameworks;

(ii) Fish species have a high capacity to adapt to various environmental conditions, which may increase the potential for persistence in the environment and may be difficult to predict;

(iii) Limited baseline data is available for fish (e.g. survival, dispersal, reproduction) and their ecological roles;

(iv) Fish behaviour is complex and difficult to predict;

(v) Lack of information on how living modified fish will interact with wild populations;

(d) Related to the aquatic receiving environment:

[29] CBD/CP/RA/AHTEG/2020/1/3.

(i) Limited baseline data is available for aquatic biodiversity and environments (e.g. levels of predation, presence of compatible species);

(ii) Aquatic environments are interconnected and dynamic, which challenges risk prediction;

(iii) Potential for living modified fish to cause irreversible damage to aquatic environments;

(e) Related to risk management:

(i) Potential for large spatial distributions makes risk management challenging;

(ii) Potential for irreversibility of release and the lack of risk management measures;

(f) Related to detection and monitoring:

(i) The potential for large spatial distributions could challenge monitoring;

(ii) Monitoring might be challenging given the potential for fish to invade various ecological niches;

(iii) Lack of standardized protocols for detection and monitoring of living modified fish;

(g) Institutional arrangements:

(i) Lack of biosafety regulatory systems for managing living modified fish;

(ii) Need for further capacity-building and development for living modified fish;

(iii) Lack of cooperation and harmonization.

113. It was also suggested that given the potential for living modified fish to cross national borders, international cooperation and regional harmonization efforts might be required to address the potential transboundary nature of these living modified organisms.

D. Specific issues concerning living modified fish

1. Potential to cause adverse effects on biodiversity

114. Regarding potential adverse impacts on biodiversity, the following were raised:

(a) Destruction of native aquatic ecosystems (e.g. generalist feeding behaviours);

(b) Altered community structures through invasion and displacement of endogenous species;

(c) Disruption of predator-pray dynamics;

(d) Alteration of ecosystem services (e.g. nutrient cycling);

(e) Reduced biological and genetic diversity (e.g. through the invasion and establishment of monocultures, hybridization with rare or endemic species);

(f) Facilitate the spread of disease to native species (e.g. in the case that the living modified fish is more susceptible to disease).

115. It was noted that fish inhabit sensitive and value habitats (e.g. coral reefs, isolated lakes), which could be more vulnerable to impacts by living modified fish. In addition, it was suggested that living modified fish could disproportionately impact indigenous peoples and local communities, leading to a negative socioeconomic impacts or loss of valued species.

116. Further, living modified fish with invasive attributes could have a larger potential to cause adverse impacts on the native ecosystems. It was noted that many fish species used in aquaculture, such as tilapia (*Oreochromis niloticus*) and barramundi (*Lates calcifer*), have invasive

characteristics. It was further suggested that if the modified traits of the living modified fish further enhance specific characteristics or confer a selective advantage in the environment, such as improving disease resistance, there could be greater potential risk.

117. In the case of Glofish® species (fluorescent living modified fish), living modified zebrafish (*Danio rerio*) were found surviving and reproducing outside the breeding facilities in Brazil. Gene flow between transgenic and non-modified fish has also been reported in Peru. A similar case was also observed with fluorescent living modified medaka (*Oryzias latipes*) in Japan.

2. Introduction into the environment

118. In their submission, the Party noted that aquaculture projects have been or are being set up on rivers, lakes, estuaries, coasts and deep-sea areas with the aim to enhance the capacity to rapidly produce large amounts of protein to meet the needs of growing populations and growing export demand. Thus, it was suggested that introduction into and unintended spread within the environment could result from accidental releases from such facilities. Some participants of the online forum noted that accidental releases of farmed fish frequently occur and in high volumes.

119. The aquarium trade was also highlighted as a potential source of introduction into the environment of ornamental fish. Examples of two non-modified invasive fish species (*Perccottus glenii* and *Ameiurus nebulosus*) and the Glofish® were shared during the online discussions.

120. During the online discussions, it was also noted that containment strategies have proven effective, such as in the case of AquAdvantage salmon. In this case, a combination of physical and biological (e.g. tripliody) were implemented to prevent the accidental release and establishment of the living modified salmon. In contrast, some participants also noted that certain biological containment strategies could be overcome in certain circumstances (e.g. the population of triploid living modified fish contains a small percentage of diploid individuals).

3. Dissemination across national borders

121. Living modified fish at all life stages (eggs, fry, fish) were suggested to spread easily in natural environments. For example, it was noted that certain species that have been known to swim long distances, quickly disseminate across jurisdictional borders and can adapt to both freshwater and estuary ecosystems (e.g. barramundi (*Lates calcarifer*)). Natural events (e.g. storms, adverse weather events) may also facilitate the movement of fish in the environment.

122. It was further suggested that human activities could also lead to transboundary movements of the living modified fish. For example, recreational activities could potentially increase the dissemination of living modified fish through river networks and lakes. Another example could be related to food commerce, which may lead to the transportation of live fish, fry and eggs across national borders and accidental releases. The aquarium trade was also raised as a source of (informal) human-mediated movement of living modified fish, such as GloFish®.

4. Commercialization status of living modified fish

123. A living modified salmon (AquAdvantage salmon) that had been commercialized in the United States of America was identified. However, it was noted during the online discussions that other fish species had been commercialized or are under regulatory review, including some that were modified using genome-editing, since the publication of the study on risk assessment in 2020. Some participants of the online forum also noted the increase in research and development of fish modified using new genomic techniques.[30]

[30] Agrifood and feed applications include Nile tilapia (*Oreochromis niloticus*), Atlantic salmon (*Salmo salar*), Channel catfish (*Ictalurus punctatus*), Common carp (*Cyprinus carpio*), Yellow catfish (*Tachysurus fulvidraco*), Sterlet (*Acipenser ruthenus*), Gibel carp (*Carassius gibelio*), Olive flounder (*Paralichthys olivaceus*), Farmed carp (*Labeo rohita*), White crucian carp (*Carassius auratus*), Mozambique Tilapia (*Oreochromis mossambicus*), Loach (*Paramisgurnus dabryanus*), Southern catfish (*Silurus meridionali*), Tiger pufferfish (*Takifugu rubripes*), Red sea bream (*Pagrus major*), Blunt snout sea bream (*Megalobrama*

124. The further commercialization of other Glofish® species, such as *Epalzeorhynchos frenatum*, *Puntius sp.*, *Corydoras sp.* and pristellas (*Pristella maxillaris*), was also shared during the online forum.

E. Existing resources on similar issues

125. Some participants of the online forum noted that there are limited guidance materials for risk assessment of living modified fish beyond those for contained use and a lack of guidance or guidelines on biocontainment and post-approval monitoring for fish species.

126. It was mentioned that the existing materials published by the Secretariat of the Convention on Biological Diversity would be important technical resources. Examples include the publication *Study on risk assessment: Application of Annex I of decision CP-9/13 to living modified fish*[31] and the dedicated webpage for living modified fish[32] have also been made available during previous considerations of the topic of living modified fish. It was further suggested the *Additional voluntary guidance materials to support-case-by-case risk assessment of living modified organisms containing engineered gene drives* provides a robust framework for conducting and informed risk assessment of any living modified organism, including living modified fish.

127. Publications published by the Organisation for Economic Co-operation and Development, the International Risk Governance Council, the European Food Safety Authority,[33] the Food and Drug Administration of the United States of America,[34] the Health and Safety Executive of the United Kingdom of Great Britain and Northern Ireland[35] and the Government of Canada were also mentioned as relevant resources. However, it was noted by some participants that these resources may require adaption to address the specific characteristics and risks associated with living modified fish, particularly in aquatic environments. For food safety, the Codex Alimentarius was noted as a key resource.

128. During the online forum, there was a view that previous experience with the AquAdvantage salmon and Glofish® could be leveraged when considering the environmental risk assessment of living modified fish.

VII. Living modified microorganisms

129. Two Parties indicated that living modified microorganisms were priority topics of risk assessment. One of the Parties further indicated the need to focus on living modified microorganisms for use in bioremediation applications.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

130. The submitting Parties indicated that living modified microorganisms fall within the scope of the Protocol as a product of modern biotechnology. Furthermore, there is the potential of living modified microorganisms to cause adverse effects on biodiversity and ecosystems, and indirect effects on human health. Thus, the topic was suggested to align with the objective of the Protocol.

131. Regarding genome-edited microorganisms, there were diverse views during the online discussions as to whether these would be considered to be “living modified organisms” as per Article 3 (Use of terms) of the Protocol.

amblycephala), Rainbow Trout (*Oncorhynchus mykiss*), Redhead cichlid (*Vieja melanura*) and Royal farlowella (*Sturisoma panamense*).

[31] CBD/CP/RA/AHTEG/2020/1/3.

[32] Available at https://bch.cbd.int/protocol/fish.shtml.

[33] European Food Safety Authority Panel on Genetically Modified Organisms (2013) Guidance on environmental risk assessment of genetically modified animals. *EFSA Journal*, vol 11, 5.

[34] United States Food and Drug Administration (2025) Intentional Genomic Alterations in Animals. Available at: https://www.fda.gov/animal-veterinary/biotechnology-products-cvm-animals-and-animal-food/intentional-genomic-alterations-igas-animals.

[35] Health and Safety Executive (2014) The Genetically Modified Organisms (Contained Use) Regulations 2014. Fifth edition.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

132. The submitting Parties and some participants of the online forum indicated that living modified microorganisms have technical challenges and regulatory gaps. For example, there was no consolidated framework to serve as a reference nor were there previously established methodological criteria. It was also mentioned that there has been little regulatory and methodological experience with the environmental release of living modified microorganisms, including those designed for bioremediation purposes, as previous experience has focused on the risk assessment of living modified crop plants.

133. The submitting Parties and some of the participants of the online forum highlighted that the main challenges posed by living modified microorganisms related to:

(a) Microbial biology;

(b) Microbial ecology;

(c) The genetic modification;

(d) Microbial evolution;

(e) Availability of data;

(f) Monitoring and surveillance;

(g) Containment and risk management.

134. During the discussions of the online forum, some participants noted that living modified microorganisms could be very broad, encompassing many types of organisms (e.g. bacteria, archaea, fungi, viruses, protists and microalgae). It was suggested that this broadness could potentially make it difficult to specifically identify challenges.

135. There was also a view that current risk assessment frameworks and methodologies could be considered to be adequate. Some participants emphasized the importance of an evidence-based, comparative and case-by-case approach to address the environmental risk assessment of living modified microorganisms. As such, Annex III to the Protocol was noted to already provide an adaptable and comprehensive framework for the case-by-case assessment of any living modified organism, allowing for the specific characteristics of the living modified organism and the receiving environment to be considered. Regarding methodologies, several participants supported the use of a problem formulation approach, which was considered to be scientifically robust, efficient, and adaptive, to address the risk assessment of living modified microorganisms.

C. Challenges in addressing the specific issue

136. Although the specific challenges would depend on the type of modified microorganism, Parties and some participants of the online forum identified the following challenges related to the risk assessment of living modified microorganisms:

(a) Related to microbial biology:

  (i) High levels of variation in microorganisms (e.g. cellular structure, genetics, reproductive mechanisms, metabolism);

  (ii) Microscopic size;

  (iii) Lack of empirical data on phenotypic characteristics (e.g. proliferation, horizontal gene transfer, mobility, population dynamics, potential for colonisation, persistence and spread);

  (iv) High reproduction rate;

(b) Related to microbial ecology:

(i) Adaptive capacity and survival in different environments (e.g. temperature, moisture, salinity, under climate change scenarios);

(ii) High potential for mobility and dispersal within the environment;

(iii) Varied roles in the biogeochemical and bioremediation processes;

(iv) Difficulties in predicting the impacts on complex interactions in the environment (e.g. on biogeochemical cycles);

(v) Potential interactions with native microbial communities and other species (e.g. holobiont) are not well-understood and difficult to model;

(vi) Limited knowledge on how horizontal gene transfer impacts on microbiomes;

(vii) Persistence in the environment;

(viii) Challenges with taxonomic identification;

(c) Related to the genetic modification:

(i) Stability of microbial traits or microbial chasses are difficult to assess;

(ii) Multi-trait stacked organisms with edited metabolic networks complicate risk assessment;

(iii) Lack of standardized methods for assessing genetic stability, fluidity, fitness and persistence (particularly under laboratory conditions);

(d) Related to microbial evolution:

(i) Rapid reproduction, capacity of recombination, natural competence and mutation rates may lead to evolutionary unpredictability or reversion;

(ii) Gaps in knowledge regarding host specificity and potential for spillover events;

(e) Related to the availability of data:

(i) Lack of knowledge and empirical data on the biodiversity of microorganisms and on natural microbial composition;

(ii) Limited characterization of water and soil in many ecosystems;

(iii) Limited information and data on complex interactions in the environment;

(iv) Scientific information might not be available on the species being modified;

(f) Related to monitoring and surveillance:

(i) Lack of visibility during initial spread and invasion;

(ii) Long-term monitoring (e.g. especially if integrated into natural gene pools);

(iii) Lack of appropriate culture conditions;

(iv) Detecting cryptic genetic circuits (e.g. quorum-sensing-controlled virulence factors);

(v) Unintended modifications in non-coding regulatory regions;

(g) Related to containment and risk management:

(i) Irreversibility of release;

(ii) Containment could be challenging post-release given microbial characteristics and the potential for large spatial distributions;

(iii) Lack of tested risk management tools.

137. Further, for living modified microorganisms for use as bioremediation applications, more than one living modified microorganism may be used (i.e. a consortium of living modified microorganisms). A consortium would then require both the individual assessments for each living modified microorganism, as well as a comprehensive analysis of the possible interactions between them and then within the receiving environment (e.g. ecological dynamics, native microbial communities). Such cases may cause challenges when conducting the risk assessment. Similarly, in the case that multiple living modified microorganisms are release in the same receiving environment, the potential interactions between the modified species, as well as with the native organisms, may also complicate the associated risk assessment.

138. It was also noted that many of the specific challenges raised during the submissions and the online forum would also be aspects that would likely be considered for other organisms. Thus, it was suggested that these elements would normally be addressed when conducting a risk assessment of any living modified organism.

D. Specific issues concerning living modified microorganisms

1. Potential to cause adverse effects on biodiversity

139. Regarding living modified organisms, there could be the potential to:

(a) Change ecological dynamics and processes (e.g. disruptions to symbiotic interactions, long-term shifts in microbial community structure, unanticipated metabolic changes);

(b) Alter biogeochemical processes (e.g. soil regeneration, nutrient cycling, water quality);

(c) Outcompete or displace native microbes (e.g. enhanced fitness or conferred traits may allow for colonization or invasion of new ecological niches);

(d) Modify food webs or altering essential symbiotic relationships within the ecosystem;

(e) Cause a loss of microbial diversity and resilience of natural microbial populations;

(f) Result in pathogenic or toxic organisms because of gene flow;

(g) Result in unintended human exposure via food products (e.g. crops exposed to living modified bacterial sprays, lettuce sprayed with manure containing modified cattle microbes, milk);

(h) Cause health implications due to unintended mutations following a gene flow event (e.g. spread of virulence factors, increased pathogenicity, altered microbiome function, spread of antibiotic resistance);

(i) Change evolutionary dynamics (e.g. mutations or recombination events lead to a potential pathogen or lead to increased pathogenicity, modified host-pathogen dynamics);

(j) Be dual-use applications.

140. Biocontainment methodologies, which are designed to limit the spread of living modified microorganisms, have the potential to contain living modified microorganisms in the environment, but yet to be tested. It was further noted that these potential strategies might be limited in both space and time.

141. Indigenous peoples and local communities place cultural value on the integrity of ecosystems and rely on stable ecosystems for agricultural, fishing and medical resources. Thus, perturbations resulting from the release of living modified microorganisms, may have the potential to adversely impact biological resources that are culturally important to these groups as well as disproportionately effect indigenous peoples and local communities, women and youth.

2. Introduction into the environment

142. Living modified microorganisms can be either intentionally or unintentionally released into the environment. Those applications for bioremediation, pest control and agriculture are intended for

environmental release. Accidental releases might be possible from laboratories, fermenters and containment facilities.

143. However, it was suggested that accidental releases into the environment may not be detected until the living modified microorganism has been established or spread beyond the area of introduction.

3. Dissemination across national borders

144. Living modified microorganisms have the potential to unintentionally cross-national borders. Once released into the environment, microorganisms can mobilize and disperse by various means, such as via wind, rain, snow, water, pollen, leaf litter, seeds, wildlife and human activities, which occur irrespective of jurisdictional borders. In addition, the biological characteristics, reproductive capacity and adaptation to different environments could further lead to the establishment and propagation of living modified microorganisms beyond the territory in which they were initially released.

4. Commercialization status of living modified microorganisms

145. According to a horizon scanning exercise conducted in 2023,[36] 35 microorganisms were identified as being developed or commercialized, of which 11 were bacteria, 22 were yeasts, one was a fungal endophyte, and one was a microalga. Eight of them were already commercialized, 9 were published in patent applications and 18 were under development at the time of publication. Furthermore, it was also shared that over 100 living modified microorganisms have been developed (e.g. *Pseudomonas putida* for bioremediation, *Saccharomyces cerevisiae* variants for industrial enzymes, CRISPR-edited cyanobacteria for carbon capture, engineered phage cocktails).

146. From the submissions and the online discussions, it can be noted that most living modified microorganisms to date have been developed for contained use and that limited commercialization has occurred for those for environmental use. One example for environmental release shared was a modified soil bacteria that was developed as a bio-fertilizer (PivotBio) and was recently commercialized.

147. The participants of the online forum and the submitting Parties did not indicate that living modified microorganisms for bioremediation had been commercially approved. However, the submitting Party noted that developments were ongoing in confined conditions and closed systems. They also noted the large increase in the number of patent applications related to the use of living modified microorganisms for bioremediation applications and suggested that authorization for environmental release would be within a near-future (10 year) timeframe. It was noted during the online discussions, that both single species and microbial consortia were being explored in research and development.

148. Regarding research and development, it was mentioned that living modified microorganisms were being proposed for a wide variety of environments (e.g. soil, livestock guts, wild animal populations, marine and freshwater ecosystems, agricultural fields) and applications (e.g. biocontrol, biofertilizers, bioremediation, public health, conservation/climate). Examples include self-spreading vaccines for wildlife (public health), the in vivo editing of animal gut microbiomes, paratransgenesis of honeybees and the modification of plant-associated microbiomes. Furthermore, it was also mentioned that creating living modified microorganisms is becoming easier due to advances in artificial intelligence. An example of ‘mirror organisms’ was provided.

[36] Ballester, Ana-Rosa and others (2023) Horizon scanning on microorganisms and their products obtained by new developments in biotechnology. *EFSA Supporting Publications*. vol. 20, 12.

E. Existing resources on similar issues

149. No specific guidelines or guidance for the risk assessment of living modified microorganisms for environmental release or living modified microorganisms for use in bioremediation applications were provided by the submitting Parties.

150. During the online discussions, it was noted that the European Food Safety Authority had published several articles specific to the risk assessment of living modified microorganisms.[37] Further, the European Food Safety Authority has also launched a process to prepare new, updated guidelines for microorganisms, viruses, fungi and microalgae in the food and feed chain, including agronomic applications, which was expected to finish later in 2025.

151. It was noted that existing guidance and guidelines, such as those for living modified crops (e.g. maize, cotton, soyabean) and living modified organisms containing engineered gene drives, could be adapted or provide elements for the risk assessment of living modified microorganisms. For example, the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives*[38] was suggested as being sufficiently flexible for the case-by-case risk assessment of any living modified organism due to this problem formulation approach. Other technical publications published by international organizations and national regulators (e.g. European Food Safety Authority, United States Environmental Protection Agency, Australian Office of the Gene Technology Regulator) would also be important to consider.

152. During the online forum, there was also a view that existing experience with other living modified organisms, as well as with (non-modified) microorganisms for biocontrol and biofertilizer uses, could inform the risk assessment of living modified microorganisms.

153. It was also raised that having biology documents specific to different species of microorganisms might be more useful for risk assessors than risk assessment guidance documents. Other suggestions included further capacity-building, global harmonization of risk assessment frameworks, knowledge exchange between regulators and the development of technical notes of key considerations specific to living modified microorganisms as important interventions to address some of the challenges identified for the risk assessment of living modified microorganisms.

VIII. Living modified organisms containing stacked events

154. One Party identified living modified organisms containing stacked events as a priority area of risk assessment.

155. Living modified organisms containing stacked events fall into two categories: breeding stacks, which are achieve through crossing living modified parental lines, or molecular stacks, which are achieved through the introduction of multiple gene cassettes, the use of re-transformation or the utilization of co-transformation protocols.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

156. The submitting Party noted that the risk assessment of living modified organisms containing stacked events is aligned with Article 15 (Risk assessment) and Annex III (Risk assessment) as the goal to minimize the potential risks to biodiversity and human health.

[37] European Food Safety Authority Panel on Genetically Modified Organisms (2011) Guidance on the risk assessment of genetically modified microorganisms and their products intended for food and feed use. *EFSA Journal*. vol. 9, 6;
European Food Safety Authority Scientific Committee and others (2020) Evaluation of existing guidelines for their adequacy for the microbial characterisation and environmental risk assessment of microorganisms obtained through synthetic biology. *EFSA Journal*. vol. 18, 10; and
European Food Safety Authority Panel on Genetically Modified Organisms and others (2024) New developments in biotechnology applied to microorganisms. *EFSA Journal*. vol. 22, 7.
[38] CBD/CP/MOP/11/9.

157. During the online forum, there was a view by some participants that the evaluation of living modified organisms containing stacked events could be considered in the context of Article 13 (Simplified procedure) and Article 14 (Bilateral, regional and multilateral agreements and arrangements). It was suggested that a streamlined risk assessment process could facilitate the implementation of the Protocol and address some of the challenges, which are detailed below.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

158. In the submission by a Party and during discussions of the online forum, the potential challenges related to the risk assessment of living modified organisms containing stacked events relate to:

(a) Molecular biology of the living modified organism;

(b) Risk assessment methodology and experience;

(c) Detection and identification;

(d) Regulatory and institutional arrangements.

159. For breeding stacked events, it was noted that there could be differences in the regulatory framework depending on whether the individual events ("single events") have been individually approved or if one of the individual events in the stacked event have not. Depending on the jurisdiction, the stacked event may require a full risk assessment even if all individual events have been assessed separately. It was noted that often countries take the approach that if a stacked event is considered to not cause adverse effects, the individual events and sub-combinations that comprise the stacked event would then also be considered to also not cause adverse effects. Since, the potential challenge relates to how single and stacked events are treated in various jurisdictions, regulatory harmonization was suggested as a solution.

160. During the discussions of the online forum, it was emphasized that stacked events necessitate a case-by-case approach, which could be challenging depending on the type of stacked event that is presented.

161. There was also a view that Annex III to the Protocol would be sufficient and would provide a framework for the risk assessment of living modified organisms containing stacked events. Some participants of the online forum noted that Annex III was sufficiently robust to predict the potential gene interactions and cases when additional information could be needed during the risk assessment of living modified organisms containing stacked events, including their intermediate sub-combinations. The problem formulation approach was mentioned as providing a scientifically-sound methodology to address the potential risk hypothesis related to the use of living modified organisms containing stacked events.

162. Regarding a solution to address the identified challenges, some participants stressed the importance of capacity-building and development, particularly for developing countries and those that are centres of origin. There could also be a focus on scientific and technical cooperation in this regard.

C. Challenges in addressing the specific issue

163. The following specific challenges related to the risk assessment of living modified organisms containing stacked events were identified:

(a) Molecular biology of the living modified organism:

(i) Lack of standardized measuring the interaction of stacked genes;

(ii) Limited understanding of how the multiple genetic elements and cassettes interact with each other and cause combinatorial effects (e.g. need for analytical approaches that integrate of genomic, transcriptomic, proteomic, epigenomic and metabolomic techniques);

(iii) Lack of information on how multiple genetic elements interact with endogenous genes within the recipient organism;

(iv) Potential for weakened stability and integrity of molecular constructs;

(v) Difficulties in determining how combined effects influence the phenotype of an organism and are affected by environmental conditions;

(vi) Knowledge gaps related to the introduced genetic elements and their interactions at the genetic level;

(vii) Difficulties in detecting and distinguish complex molecular effects in the presence of multiple transgenes;

(b) Risk assessment methodology and experience:

(i) Lack of methodologies and empirical data to assess long term affects of living modified organisms containing stacked events on biodiversity and human health;

(ii) Absence of established risk assessment methodologies for assessing combinatorial effects of multiple transgenic sequences;

(iii) Lack of baseline descriptions for the use of a non-comparative approach to risk assessment;

(iv) Failure to address unintended synergistic and antagonistic effects of stacking transgene sequences using current risk assessment methodologies;

(v) Lack of experience with other types of organisms containing stacked events (e.g. microorganisms, animals);

(vi) Limited experience with stacked events beyond those that express multiple proteins (e.g. those that containing gene silencing constructs, those containing genome-editing arrays, mixtures of different types of constructs);

(c) Detection and identification:

(i) Challenges to distinguish stacked events from individual events (e.g. mixed shipments, crushed grains, food and feed samples, bulk environmental samples) using current analytical tools;

(ii) Limited availability of detection methodologies of stacked events;

(d) Regulatory and institutional arrangements:

(i) Limited expertise and capacity in some countries to conduct nuanced risk assessment of stacked events;

(ii) Lack of harmonized data requirements and risk assessment methodologies across countries;

(iii) Inconsistent regulation among Parties regarding living modified organisms containing stacked events;

(iv) Lack of access to data (e.g. full access to proprietary studies submitted in other jurisdictions might be restricted);

(v) Limited or lack of capacity for environmental monitoring.

164. For breeding stacked events, there was a view that a wealth of experience exists. One participant noted that over 360 cultivation authorizations and 1,100 food and feed authorizations have been taken on stacked events. However, some participants of the online forum highlighted that the application of new genomic techniques may also be used in the parental lines, which may bring

additional challenges, such as off-target events and unexpected interactions, which may be difficult to assess.

D. Specific issues concerning living modified organisms containing stacked events

1. Potential to cause adverse effects on biodiversity

165. Some participants of the online forum noted that the combinatorial effects of living modified organisms containing stacked events could:

(a) Reduce genetic diversity through gene flow (e.g. introgression of transgenes into local varieties, erode local crop genetic diversity through crossing);

(b) Cause unintended toxic effects on beneficial organisms (e.g. soil microbiota, pollinators, beneficial insects);

(c) Lead to the development of resistance in target organisms (e.g. insecticide resistance, herbicide tolerance);

(d) Lead to immunogenicity;

(e) Cause adverse health affects due to chromic exposure (e.g. alterations in microbiota);

(f) Lead to unintended pleiotropic effects;

(g) Result in creased use of herbicides and pesticides.

166. Other participants noted that the potential adverse effects would be substantively similar to the individual events and noted the cultivation of living modified crops for 30 years.

2. Introduction into the environment

167. It was noted that living modified organisms containing stacked events may be introduced intentionally into the environment during field trials or following commercialization and accidentally due to weak border control or biosafety infrastructure.

3. Dissemination across national borders

168. It was noted that regional seed trade and differences in regulatory approval may lead to unintentional transboundary movements of living modified organisms containing stacked events.

4. Commercialization status of living modified organisms containing stacked events

169. Many stacked events have been commercialized globally, such as in the United States of America, India and Brazil, among others, for several years.

170. It was noted that, as of June 2025, there were 386 living modified organisms containing stacked events registered on the Biosafety Clearing-House, which accounts for one third of the total database. However, it can be observed that most living modified crops grown are stacked events. There was a view that this demonstrates the need to address this topic of risk assessment.

E. Existing resources on similar issues

171. During the online discussions, it was noted that there are several guidance and reference materials available on this topic. Examples include those that have been produced by Codex Alimentarius,[39] the Organisation for Economic Co-operation and Development[40] and the European

[39] See https://www.fao.org/fao-who-codexalimentarius/thematic-areas/biotechnology/en/.

[40] Organisation for Economic Co-operation and Development. (2023). *Safety Assessment of Transgenic Organisms in the Environment, Volume 10: OECD Consensus Document on Environmental Considerations for the Release of Transgenic Plants, Harmonisation of Regulatory Oversight in Biotechnology*. Paris: OECD Publishing; see also https://www.oecd.org/en/topics/sub-issues/biosafety-novel-food-and-feed-safety/consensus-documents-on-the-safety-of-novel-foods-and-feeds.html.

Food Safety Authority.[41] Further, it was noted that several African countries, including Ghana and Nigeria,[42] have developed and published guides for living modified crops containing stacked genes.

172. Some participants also suggested that the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives*[43] would be broadly applicable to any living modified organisms, including those containing stacked events, due to the problem formulation approach taken by the publication.

173. The Regulatory Cooperation for Biotechnology[44] initiative by the Agriculture and Food Systems Institute was also highlighted as a resource containing a database of case studies, which could be informative with regard to the risk assessment of living modified organisms containing stacked events.

174. There was a view that guidance or guidelines containing suggestions and recommendations to support partial or full harmonization for the risk assessments of stacked events between Parties might address the potential specific challenges that have been raised. Other participants expressed the need for guidance to reflect a wider range of organisms containing stacked events, safety considerations for non-target organisms and the potential trade implications following the use of such living modified organisms. In addition, given that the majority of living modified organisms containing stacked events are insect-resistant and herbicide-tolerant, there was a suggestion to include information regarding best practices for the use of agrochemicals in guidance materials.

IX. Living modified organisms expressing genome editing machinery for pest or pathogen control

175. One Party identified living modified organisms expressing genome editing machinery for pest or pathogen control as a priority of risk assessment.

176. These living modified organisms express genome editing machinery to modify other target organisms for pest or pathogen control, by inducing modifications to cause lethality, result in sterility or alter traits (e.g. changed behaviour, altered sensory perceptions). Current examples include bacterial sprays expressing CRISPR[45] for controlling agricultural pests and engineered probiotics to modify poultry or livestock guts or microbiomes.

177. During the discussions of the online forum, information was also provided regarding genome-edited organisms and living modified organisms containing engineered gene drives. To complement the information originally provided by the Party in their submission and to avoid duplication with other topics as much as possible, the information below relates to those living modified organisms that express or transfer genome editing machinery to induce genome editing in an exposed organism.

[41] European Food Safety Authority (2007) Guidance Document for the risk assessment of genetically modified plants containing stacked transformation events by the Scientific Panel on Genetically Modified Organisms (GMO). *EFSA Journal*, vol. 5, 7;
European Food Safety Authority Panel on Genetically Modified Organisms (2011) Guidance for risk assessment of food and feed from genetically modified plants (GMO). *EFSA Journal*, vol. 9, 5; and
European Food Safety Authority Panel on Genetically Modified Organisms (2013) Guidance on environmental risk assessment of genetically modified animals. *EFSA Journal*, vol 11, 5.

[42] National Biosafety Management Agency (2022) National biosafety guidelines for risk assessment and risk management of genetically modified plants with stacked genes. Available at https://nbma.gov.ng/wp-content/uploads/2022/09/NATIONAL-BIOSAFETY-GUIDELINES-FOR-RISK-ASSESSMENT-AND-RISK-MANAGEMNT-OF-GM-PLANTS-WITH-STACKED-GENES.pdf; National Biosafety Authority (2023) Guidelines for applications on genetically modified organisms with stacked genes in Ghana. Available at https://nba.gov.gh/wp-content/uploads/2024/05/Guidelines-for-Application-on-Genetically-Modified-Organism-with-Stacked-Genes.pdf.

[43] CBD/CP/MOP/11/9.

[44] Available at https://biotechpolicyportal.org/case-studies/.

[45] Clustered interspaced short palindromic repeats (CRISPR).

A. Relationship to the scope of the Cartagena Protocol on Biosafety

178. In their submission, the Party indicated that these organisms would be considered to be "living modified organisms" in line with Article 3 (Use of terms) of Protocol as these organisms contain a transgene sequence encoding CRISPR proteins. It was further noted that these living modified organisms could have the potential for adverse effects on the conservation and sustainable use of biological diversity, thus could be considered to be within the scope of the Protocol.

179. It was also noted that these living modified organisms could then generate modification in another organism, which might be considered to create new living modified organisms in the environment. However, during the online discussions, there were diverging views as to whether genome editing of organisms in the environment would generate new living modified organisms.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

180. The main challenges raised in relation to existing risk assessment frameworks, guidance materials and available methodologies were related to:

(a) Experience with the living modified organism;

(b) Novel trait or exposure in the receiving environment;

(c) Gene flow;

(d) Long-term assessment;

(e) Detection and monitoring;

(f) Risk management.

181. Since living modified organisms expressing genome editing machinery actively modify other organisms in the environment, it was suggested that the risk assessment of such organisms could be considered to be different from conventional risk assessment of living modified organisms, which tends to only consider the living modified organism being released. Thus, there was a view that current risk assessment frameworks have not yet been developed to address the further modification of species following the release of these living modified organisms.

182. During the discussions of the online forum, it was noted that some of the challenges to risk assessment potentially posed by living modified organisms expressing genome editing machinery could be similar to living modified organisms produced through new biotechnologies, living modified microorganisms and living modified organisms containing engineered gene drives.

183. In contrast, some participants noted that Annex III to the Protocol would still be sufficient and provide a scientific basis for the risk assessment of such living modified organisms. Furthermore, the case-by-case basis of risk assessment and a problem formulation were also emphasized by some participants as being scientifically robust to inform the risk assessment of these types of living modified organisms.

C. Challenges in addressing the specific issue

184. The potential specific challenges raised in relation to living modified organisms expressing genome-editing machinery were:

(a) Related to the experience with the living modified organism:

(i) Lack of experience with assessing organisms that cause genetic modification in other organisms in the receiving environment (e.g. most experience is with the risk assessment of living modified annual crops and those with stable modifications);

(ii) Difficulty in identifying suitable comparators;

(b) Related to the novel trait or exposure in the receiving environment:

(i) Difficulties in predicting which species would be affected by the action of the genome editing machinery (e.g. multiple species could be modified, species could be modified multiple times) since available sequencing data is limited to select number of organisms and may not represent natural variants;

(ii) Difficulties in predicting the unintended outcomes of genome editing machinery (e.g. viral recombination, off-target editing, exposure to genetically diverse and/or uncharacterized species, lack of available sequencing data for all exposed species);

(iii) Complexities surrounding the risk assessment on a larger scale (e.g. multiple organisms and species could be genome-edited in the environment);

(iv) Incomplete understanding of microbiomes and their functions;

(c) Related to gene flow:

(i) Difficulties predicting outcomes in the case that the genome editing machinery was transferred to other species (e.g. through conjugation, natural competence);

(ii) Gene flow may not be restricted by species barriers and thus could increase exposure;

(d) Related to long-term assessment:

(i) Uncertainty in how to account for evolution of the genome editing machinery (e.g. action of the protein, changes in the guide RNAs);

(ii) Potential for persistence in the environment might be difficult to assess;

(e) Related to detection and monitoring:

(i) Genome editing may result in genomic edits that are indistinguishable from natural variant;

(ii) Detecting and monitoring at a larger scale might be challenging;

(f) Related to risk management:

(i) Feasibility of applying risk management measures to all affected species;

(ii) Risk management measures may not have been developed yet.

D. Specific issues concerning living modified organisms expressing genome editing machinery for pest or pathogen control

1. Potential to cause adverse effects on biodiversity

185. The following potential adverse effects on biodiversity were mentioned in both the submission from the Party and during the discussions of the online forum:

(a) Unintended effects resulting from genome editing can potentially introduce unforeseen hazards, in particular when considering that non-target organisms may be exposed and potentially modified;

(b) Competition with native species may alter ecosystem dynamics and reduce biodiversity;

(c) Unintended modification of or adverse impacts on rare species that hold particular health, economic or culture value;

(d) Pathogen targeted by genome editing machinery may evolve resistance;

(e) Unintended persistence in the environment and lack of controllability;

(f) Gene flow may not be restricted to species barriers.

2. Introduction into the environment

186. It was noted that living modified organisms that express genome editing machinery may be released either intentionally (as intended based on the particular trait and application) or accidentally (such as in the case of an escape from a laboratory). Organisms targeted by the genome editing machinery would be in the environment.

3. Dissemination across national borders

187. In terms of the organism itself, it was suggested that living modified organisms that express genome editing machinery are microorganisms, which could have a high potential for dissemination, including in the air (via pollen), through rain, by insects, on leaf litter and seeds.

188. Further, there might be the potential for food and feed to be in contact with these living modified organisms as some applications have been designed for use in animal feeds. These applications for animal feed may also spread via sewage in rivers or in marine environments.

4. Commercialization status of living modified organisms expressing genome editing machinery for pest or pathogen control

189. A limited number of living modified organisms expressing genome editing machinery have been commercialized. One example includes the Guided Biotics Platform® by Folium Science, which uses living modified *Escherichia coli* that expresses CRISPR systems to target gut pathogens in chickens.

190. At the time of submissions, sprays to address bacterial diseases in crops are also under development.

E. Existing resources on similar issues

191. At the time of submission, the submitting Party could not identify any materials to support risk assessment on this particular topic.

192. It was suggested that the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives* contains relevant information and considerations that could support the risk assessment of living modified organisms expressing genome editing machinery.

X. Living modified organisms for food, feed and processing

193. Two Parties indicated living modified organisms for food, feed and processing as a priority topic of risk assessment. One of the submitting Parties further indicated the human consumption of living modified maize as a particular need for guidance on risk assessment.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

194. The submitting Parties noted that the topic of living modified organisms for food, feed and processing falls within the scope of the Protocol as human health should be taken into account. Furthermore, some countries have a heavy reliance on imported food and/or are centres of origin for important crops.

195. It was also mentioned that addressing chronic adverse effects on health and biodiversity is also in line with the precautionary principle and Article 8(g) of the Convention on Biological Diversity.

196. During the online discussions, it was raised that the food safety elements related to this topic might be best addressed by Codex Alimentarius.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

197. In the submissions by Parties and in some of the interventions during the online forum, the following challenges in relation to the risk assessment of living modified organisms for food, feed and processing were related to:

(a) Human health;

(b) Agrobiodiversity;

(c) Supporting data and information for risk assessment.

198. Many participants of the online forum mentioned that living modified organisms for food, feed or processing would not pose challenges to existing risk assessment frameworks, guidance or methodologies. Information requested in related to both Annex II and Annex III to the Protocol and guidelines published by the Codex Alimentarius Commission were suggested as being fit-for-purpose when considering the risk assessment of living modified organisms for food, feed and processing. Some participants also suggested that a wealth of experience and previously conducted risk assessments of these types of living modified organisms should be sufficient resources for addressing these types of living modified organisms.

199. Further, it was mentioned that the challenges faced by some Parties might relate to implementation of existing risk assessment frameworks, the need for further capacity building and development, or unintended uses rather than specific challenges to existing risk assessment frameworks. Regional harmonization, international cooperation, data transportability, knowledge-sharing and adaptation of international guidelines to local contexts were also proposed as concrete measures to address this topic of risk assessment.

C. Challenges in addressing the specific issue

200. The following potential specific challenges were raised with respect to the risk assessment of living modified organisms food, feed and processing:

(a) Related to human health:

(i) Challenges in evaluating chronic exposure (e.g. long timescales);

(ii) Lack of short-, medium- and long-term epidemiological data on the consumption of food produced from living modified organisms;

(iii) Knowledge gaps related to the microbiome;

(iv) Knowledge gaps on the immune system and inflammatory processes;

(v) Lack of information on the combinatorial effects related to stacked events or consumption of several living modified organisms;

(vi) Lack of data on the interactions with residues from spraying herbicides;

(vii) Limited information on how plant constituents impact toxicity of the expressed novel proteins;

(b) Related to agrobiodiversity:

(i) Lack of tools to predict the potential adverse effects on agrobiodiversity;

(ii) Lack of information on how to assess effects of a broad range of environmental conditions on gene expression and plant composition;

(c) Related to data and information for risk assessment:

(i) Lack of context-specific data (e.g. ecological, agricultural and dietary data) might be a challenge where the conditions of the importing country differ significantly.

201. During the discussions of the online forum, it was noted that developing countries may face challenges addressing the specific challenges due to limited capacity to formulate, implement and enforce biosafety regulations, as well as conduct risk assessments.

202. Furthermore, it was suggested that risk assessment methodologies could be improved by incorporating genomic, transcriptomic, proteomic and epigenomic data; the impact on agricultural practices; modelling on new and innovative risk management measures; risk communication; cost-benefits analysis in cases where resources are limited; indigenous and local data and knowledge; and right-based approaches.

203. It was also noted that it would be important that risk assessment frameworks promote and support locally developed living modified organisms generated with local knowledge and suited to the local socioeconomic and ecological conditions. These might be more adapted local contexts and could address some of the challenges raised. Similarly, holistic approaches to biosafety and biosecurity, such as cross-sectorial approaches with invasive alien species, could also be of overall benefit to national risk analysis.

D. Specific issues concerning living modified organisms for food, feed and processing

1. Potential to cause adverse effects on biodiversity

204. Regarding the potential adverse effects on biodiversity, the following were indicated:

(a) Genetic erosion of genetic resources in cases where living modified crops are grown in their centre of origin (e.g. related to biocultural value of traditional varieties or reduced genetic resources for climate adaption);

(b) Potential allergenicity or toxicity related to the introduced transgene (e.g. for human or animal consumption);

(c) Human diseases linked to the chronic exposure of herbicides (e.g. in the case of herbicide-tolerant crops) and insecticidal proteins (e.g. Bacillus thuringiensis crystal protein);

(d) Reduction in ecosystem services (e.g. pollination and soil health);

(e) Development of “superweeds”, which develop through the selective pressure caused through the overuse of herbicides;

(f) Reduction in agrobiodiversity through the use of monocultures.

205. During the discussions of the online forum, it was noted that indigenous peoples and local communities, women and youth would also likely be affected by the potential impacts of living modified organisms for food, feed and processing.

206. Several participants mentioned that living modified organisms for food, feed and processing have been used since 1995 and have not demonstrated adverse effects in comparison to their non-modified counterparts.

2. Introduction into the environment

207. Regarding the introduction in the environment, it was noted that living modified organisms for food, feed and processing have been introduced both deliberately and unintentionally. In one of the submissions by Parties, unintended persistence of transgenic sequences in the environment was noted as being previously detected.

208. During the discussions of the online forum, it was also mentioned that living modified organisms for food, feed and processing may not be released into the environment depending on the final end product.

3. Dissemination across national borders

209. For living modified organisms for food, feed and processing, it was noted that these living modified organisms are linked to international trade. In one of the submissions by Parties, it was mentioned that transgenic sequences have been previously detected in imported food products.

4. Commercialization status of living modified organisms for food, feed and processing

210. Participants of the online forum noted that many living modified organisms for food, feed and processing have been commercialized and are commonly trade internationally. Commercialized varieties can be found in the Biosafety Clearing-House,[46] the Genetically Modified Foods Platform[47] of the Food and Agriculture Organization of the United Nations and the BioTrack Product Database[48] of the Organisation for Economic Co-operation and Development.

E. Existing resources on similar issues

211. One of the submitting Parties did not indicate that there were existing resources or frameworks that would be sufficiently comprehensive for their national context related to the consumption of living modified organisms, particularly maize.

212. During the online discussions, several participants noted the existence of many guidance documents related to the risk assessment of living modified organisms for food, feed and processing, including guidance from the Codex Alimentarius Commission, the European Food Safety Authority, the European Food Safety Authority, National Academies of Sciences, Engineering and Medicine, the Food and Agriculture Organization of the United Nations, the World Health Organization, the Organisation for Economic Co-operation and Development and Health Canada.[49] It was stressed that efforts should not be duplicated.

213. It was also suggested that global biosafety databases, such as the Biosafety Clearing-House, the BioTrack Product Database and the Genetically Modified Foods Platform, could serve as information and knowledge sharing tools to support the risk assessment of living modified organisms for food, feed and processing.

XI. Living modified organisms produced through new biotechnologies

214. Two Parties indicated the topic of living modified organisms produced through new biotechnologies as a priority area of risk assessment.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

215. It was suggested that the topic of living modified organisms produced through new biotechnologies falls within the scope of the Protocol due to its relationship to Article 7 (Application of the advanced informed agreement) and Annex III (Risk assessment).

216. During the discussions of the online forum, there were diverging views on whether that some organisms produced through new biotechnologies (e.g. genome-edited organisms containing small base pair changes) would be within the scope of the Protocol based on the definition of "living modified organism".

B. Challenges to existing risk assessment frameworks, guidance and methodologies

217. Regarding living modified organisms produced through new biotechnologies, the potential challenges to risk assessment frameworks, guidance and methodologies raised by Parties and some participants of the online forum were related to:

[46] Available at https://bch.cbd.int.
[47] Available at https://www.fao.org/food/food-safety-quality/gm-foods-platform/en/.
[48] Available at https://biotrackproductdatabase.oecd.org.
[49] Refer to CBD/CP/RA/AHTEG/2025/1/INF/2.

(a) Speed of development;

(b) Genetic modification;

(c) Receiving environment;

(d) Regulatory oversight;

(e) Risk assessment methodology;

(f) Transboundary movements;

(g) Detection and traceability.

218. It was noted by some participants that living modified organisms produced through new biotechnologies may have potential challenges similar to some of the other proposed topics (e.g. genome-edited mammals for agriculture, living modified organisms expressing genome editing machinery) depending on the modified organism.

219. During the discussions of the online forum, it was noted by several participants that the topic could be considered broad, encompassing many different types of organisms modified through the use of a variety of biotechnologies. Thus, it might be difficult to specifically and clearly define the specific challenges. It was also suggested that the specific type(s) of biotechnology might also need to be defined before guidance could be developed.

220. Nonetheless, it was noted that Annex III to the Cartagena Protocol on Biosafety would provide a scientifically sound structure to allow for conducting case-by-case risk assessments. Furthermore, several participants suggested that a problem formulation approach would be sufficiently flexible and robust to address any organism produced through new biotechnologies. It was also suggested that further capacity-building and contextualized training might be sufficient to address the practical application of current risk assessment frameworks for these new developments in modern biotechnology.

221. However, it was also noted by some participants during the online discussions that there is regulatory ambiguity surrounding this topic as countries have taken different approaches with regard to certain organisms produced through new biotechnology (e.g. genome-edited organisms or those modified using base-editing techniques may not be considered to be “living modified organisms” in some jurisdictions). These divergences may lead to different approaches being taken with respect to the risk assessment of these modified organisms produced through new biotechnologies. Several participants mentioned that regulatory harmonisation might be required.

C. Challenges in addressing the specific issue

222. The potential specific challenges related to living modified organisms produced through new biotechnologies may relate to:

(a) The speed of development:

(i) Regulatory lag related to the need to update risk assessment frameworks to address novel organisms and characteristics;

(b) The genetic modification:

(i) Difficulties in assessing the complexity and novelty of the introduced changes (e.g. use of artificial intelligence, new biochemical pathways expressed);

(ii) Broad range of traits and species can now be potentially modified;

(iii) Difficulties in predicting, assessing and modelling the subtle or systematic changes resulting from the use of new molecular tools (e.g. genetic instability);

(iv) Limited knowledge on long term and evolutionary changes;

(c) The receiving environment:

(i) Lack of predictive ecological models;

(ii) Difficulty in predicting complex ecological interactions, including dispersal in the environment;

(iii) Lack of regulations to address the disruption of food webs;

(iv) Difficulties in predicting and understanding the interaction of the modifications in the ecosystem;

(v) Complexities in assessing all potential risks due to the scale of modification and the modification occurring in outdoor environments, particularly if the living modified organism is designed to modify organisms in the receiving environment (e.g. different vertical and horizontal gene flow/modification pathways might be possible);

(d) Regulatory oversight:

(i) Increased potential for development may take place in non-controlled environments (e.g. outside of laboratories) with limited oversight;

(e) Risk assessment methodology:

(i) Choice of comparators may be complicated (e.g. in the case of null segregants, synthetic organisms);

(f) Transboundary movements:

(i) Lack of transboundary frameworks, particularly for international cooperation;

(ii) High potential for transboundary movement for traits that are meant for intentional spread, which would may transboundary movements more likely;

(iii) Challenges to prior and informed consent are possible (e.g. organisms created in informal settings, traits designed to propagate through natural populations);

(g) Detection and traceability:

(i) Inability to distinguish and trace genome-edited organisms from naturally-occurring variants using current detection tools.

D. Specific issues concerning living modified organisms produced through new biotechnologies

1. Potential to cause adverse effects on biodiversity

223. Regarding the potential adverse effects on biodiversity, living modified organisms produced through new biotechnologies would have different potential impacts depending on the specific organism and case. However, the following potential adverse effects were raised:

(a) Cause irreversible changes in ecosystems (e.g. potential elimination of a species, alter ecosystem dynamics, change ecological niches);

(b) Erode genetic diversity, which could undermine food security and resilience to climatic changes;

(c) Introduce novel biochemical pathways that have unpredictable adverse effects on local biodiversity;

(d) Gene flow may allow for adverse effects in ecosystems across national borders.

224. As new biotechnologies are adapted to local conditions and varieties, there could be further considerations for rural, indigenous and local communities, which rely on biodiversity for their food,

medicine and cultural practices as living modified organisms may impact on traditional agricultural systems and valued species. Thus, there could also be concerns related to ownership, access and use of biotechnologies as they related to traditional varieties, breeds or genetic resources.

2. Introduction into the environment

225. It was suggested that living modified organisms produced through new biotechnologies may be introduced into the environment depending on the specific case. Furthermore, it was noted that new biotechnologies may facilitate the modification of organisms in informal settings (i.e. outside of laboratories), which may not have biosecurity measures in place to avoid unintentional or accidental release into the environment.

3. Dissemination across national borders

226. Depending on the trait and the characteristics of the modified organism, some participants of the online forum noted that transboundary movements were possible.

4. Commercialization status of living modified organisms produced through new biotechnologies

227. During the discussions of the online forum, examples of commercialized organisms or those in field trials were shared, including genome-edited plants (e.g. soy, tomato, maize, rice), genome-edited livestock (e.g. cattle, pigs), genome-edited fish, *Escherichia coli* expressing CRISPR to target *Salmonella sp.* and precision-guided sterile insects. It was further noted that there were also several examples of new developments, such as minicells for encapsulating biological materials and de-extinction research.

E. Existing resources on similar issues

228. During the discussions of the online forum, the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives*[50] published by the Secretariat and the *Guidance framework for testing genetically modified mosquitoes*[51] published by the World Health Organization were shared as being existing guidance on the topic. Furthermore, it was noted that any guidance developed should avoid duplicating existing guidance materials.

229. In addition, it was suggested that regional tools and protocols, such as those developed by the African Union Development Agency's New Partnership for Africa's Development, could be useful resources in considering living modified organisms produced through new biotechnologies or adapting existing frameworks to local contexts.

230. However, at the time of the online forum, some participants noted that there was a lack of guidance on living modified organisms that modify other organisms in the environment.

231. It was suggested that existing resources produced under the programmes of work of the Convention on Biological Diversity could guide in the integration local knowledge of indigenous peoples and local communities and allow for gender mainstreaming.

XII. Long-term and cumulative effects of genetic constructs and living modified organisms

232. One Party indicated that long-term and cumulative effects of genetic constructs and living modified organisms was a priority topic of risk assessment.

[50] CBD/CP/MOP/11/9.
[51] World Health Organisation (2021) Guidance Framework for Testing Genetically Modified Mosquitoes, second edition. Geneva.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

233. The submitting Party indicated that this topic is related how risk assessment is conducted in line with Annex III of the Cartagena Protocol. The Party also suggested that the topic could be expanded to incorporate socioeconomic considerations in line with Article 26 of the Protocol.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

234. The challenges related to long-term and cumulative effects of genetic constructs and living modified organisms were suggested as being related to:

(a) Scale;

(b) Receiving environment;

(c) Modelling;

(d) Risk assessment methodologies;

(e) Monitoring;

(f) Risk management.

235. During the online forum, it was suggested by some participants that this topic is becoming more relevant owing to the increased complexity and diversity of living modified organisms being developed. These innovations may introduce increased or novel uncertainties with regard to effects that could potentially occur over multiple generations or accumulate across landscapes, populations, or ecosystems.

236. Some participants suggested that the existing risk assessment methodologies and principles would be applicable regardless of the organism or the technology used in the modification process. For example, the case-by-case approach established by Annex III to the Protocol was mentioned as providing a methodology for determining the acceptability of risk and containing provisions to address uncertainty, such as risk management and monitoring.

237. There was also a view shared that experience with the assessment of several traits and events (i.e. different modifications) and the same event multiple times (i.e. repeated assessments of a particular living modified organism across different contexts) over the last 30 years would be sufficient to address this proposed topic of risk assessment.

238. Solutions to address the challenges were also proposed during discussions of the online forum. These could include strengthening technology transfer, technical cooperation and information sharing, as well as sustained capacity-building initiatives. Establishing and strengthening biosafety frameworks and competent national authorities, regional collaboration and long-term monitoring were also mentioned as potential solutions.

C. Challenges in addressing the specific issue

239. Regarding to long-term and cumulative effects of genetic constructs and living modified organisms, the potential specific challenges in addressing the topic may relate to:

(a) Scale:

(i) Increased uncertainty and reliability in risk assessment due to large spatial and temporal dimensions;

(ii) Limited understanding of how evolutionary forces will act on transgenic sequences, as well as target and non-target organisms;

(iii) Increased uncertainty resulting from a large number of releases over long periods of time or from multiple living modified species in the same environment;

(iv) Limited availability of long-term and multigenerational data (e.g. most data generated was collected for single events, in isolation and over short periods of time);

(b) Receiving environment:

(i) Increased uncertainties resulting from abiotic changes (e.g. climate change), change in land use (e.g. agricultural practices, urbanization) in the receiving environment over time;

(ii) Increased uncertainty related to the simultaneous releases of living modified organisms into the same receiving environment;

(iii) Difficulties in predicting biotic and abiotic interactions and feedback effects;

(iv) Limited empirical data on persistence of genetic constructs in the environment;

(c) Modelling:

(i) Lack predictive models and tools to assess the cumulative and multigenerational effects of transgenes and living modified organisms;

(ii) Difficulties in predicting indirect effects;

(d) Risk assessment methodologies:

(i) Need to develop standardized protocols to analyze synergies and interactions of living modified organisms containing stacked events and multiple living modified organisms in the same ecosystem;

(ii) Long-term effects may be overlooked in current risk assessment methodologies and frameworks (e.g. gene flow, epigenetic changes, or ecological shifts may take years to emerge);

(iii) Difficulty in measuring socioenvironmental impacts with traditional quantitative approaches, which may require integration of other areas of knowledge;

(iv) Lack of experience and history of safe use for regulatory and epigenetic constructs (e.g. RNA interference);

(v) Gaps and experience in assessing interactions between transgenes and their associated agro-chemicals;

(e) Monitoring:

(i) Requirement for long-term monitoring (e.g. for the detection of high impact adverse effects);

(ii) Challenges to monitoring all relevant elements (e.g. gene flow, ecological impacts, parasite or pathogen evolution);

(iii) Lack of regulatory and institutional mandates for long-term monitoring;

(iv) Need for further development of detection and monitoring tools;

(f) Risk management:

(i) Knowledges gaps regarding long-term effectiveness of biocontainment systems (e.g. kill switches and engineered auxotroph);

(ii) Challenges related to applications that are intended to persist across multiple generations (e.g. in the case of slow spreading engineered gene drives or daisy drive systems).

240. There was also a view that there was uneven capacity-building and limited availability of data across for Parties to the Protocol, which may create specific challenges.

241. It was also emphasized that case-by-case and context-specific approach was important for understanding the potential challenges posed by specific living modified organisms.

D. Specific issues concerning long-term and cumulative effects of genetic constructs and living modified organisms

1. Potential to cause adverse effects on biodiversity

242. The following potential adverse impacts were raised in the submission from the Party and some of the participants of the online forum:

(a) Disruption of trophic interactions and shifts in ecosystem dynamics;

(b) Displacement of native species;

(c) Unintended persistence in the environment may lead to interactions with sensitive or endemic species, especially in biodiversity hotspots or vulnerable ecosystems;

(d) Unintended off-target impacts as a result of the genetic modification (e.g. the use of genome editing causing deletions and chromosomal rearrangements);

(e) Unintended evolutionary responses (e.g. development of pest resistance, weediness);

(f) Erosion of genetic diversity (e.g. particularly for species values by indigenous peoples and local communities);

(g) Adverse affects on human health due to chronic exposure of ecosystems to agro-chemicals as a result of using living modified organisms and genetic constructs.

243. A case-by-case and context-specific approach was mentioned as being essential when considering the potential adverse effects of a living modified organism as it allows for considerations of the specific ecological contexts of the receiving environment, while supporting science-based decision-making.

2. Introduction into the environment

244. It was noted that many living modified organisms have been designed for intentional introduction into the environment. Many have been deployed in open systems or undergoing field trials (e.g. for agricultural use, for vector control purposes).

245. Accidental release into the environment may also occur due to containment failure or unintended transport (e.g. seeds, spores). During the online forum, one participant noted that the unintended presence of transgene sequences in native maize and cotton populations was found in Mexico.

3. Dissemination across national borders

246. During discussions of the online forum, it was suggested that long-term persistence of living modified organisms may increase the likelihood of transboundary movements, whether through natural dispersion (e.g. wind, water, animal vectors) or human-mediated activities (e.g. trade, food imports).

4. Commercialization status of living modified organisms

247. Many living modified organisms have been commercialized since the 1990s. Examples include herbicide-tolerant, insect-resistant crops, living modified sterile insects and living modified organisms containing stacked events.

248. During the online forum, it was suggested that as a result of the use of genome editing and synthetic biology techniques, a greater number and diversity of modified organisms could be introduced into the environment or occur at larger scales.

E. Existing resources on similar issues

249. During the discussions of the online forum, it was mentioned that several relevant guidance documents have been published by the Secretariat of the Convention on Biological Diversity, the Food and Agriculture Organization of the United Nations, the World Health Organization and the European Food Safety Authority. Specific examples shared include the *Additional voluntary guidance materials to support case-by-case risk assessment of living modified organisms containing engineered gene drives*,[52] *Guidance on the Post-Market Environmental Monitoring (PMEM) of genetically modified plants*,[53] *Biosafety Resource Book*[54] and the *Guidance framework for testing of genetically modified mosquitoes*.[55]

XIII. Operationalizing protection goals into relevant assessment and measurement end points

250. Two Parties indicated that operationalizing protein goals in relevant assessment and measurement end points as a need or priority for risk assessment.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

251. Operationalizing of protection goals into relevant assessment and measurement end points is directly related to Article 15 (Risk assessment) and 16 (Risk management) of the Protocol. It was also noted that the overall protection goal is related to the objective of the Protocol (Article 1).

B. Challenges to existing risk assessment frameworks, guidance and methodologies

252. During discussions of the online forum, the participants recognized that approaches for translating protection goals into assessment and measurement end points vary across countries due to differing national priorities, policies and legal frameworks. It was also noted that guidance materials exist, which articulate the role of assessment and measurement end points in the risk assessment of living modified organisms, including their derivation from protection goals. Despite the available guidance and approaches, the main challenge relates to the practical implementation by Parties.

253. Several participants suggested that while the translation of broad protection goals into specific assessment and measurement end points may present logistical and contextual challenges, it is not inherently a complex or insurmountable task. It was noted that the operationalization of protection goals into relevant assessment and measurement end points can be done following Annex III to the Protocol and defining pathways to harm. There were also suggestions to promote capacity-building, regional cooperation and harmonized risk assessment protocols.

C. Challenges in addressing the specific issue

254. The submitting Parties and the participants of the online forum raised the following potential specific challenges:

(a) Many countries have not specifically defined assessment and measurement end points in the context of risk assessment and risk management (e.g. implications on monitoring plans);

[52] CBD/CP/MOP/11/9.
[53] European Food Safety Authority on Genetically Modified Organisms (2011) Guidance on the Post-Market Environmental Monitoring (PMEM) of genetically modified plants, *EFSA Journal*, vol. 9, 8.
[54] Brandenberg and others (2011) Biosafety Resource Book. Food and Agriculture Organization of the United Nations. Rome.
[55] World Health Organisation (2021) Guidance Framework for Testing Genetically Modified Mosquitoes, second edition. Geneva.

(b) Protection goals and specific assessment end point are defined in a general manner in some cases and could lead to varying interpretations among Parties;

(c) The explicit process of translating protection goals into assessment and measurable end points for risk assessment of living modified organisms remains either undocumented or embedded within national procedures without clear articulation;

(d) Varying approaches are taken by Parties with respect to defining protection goals, assessment end points, measurement end points and the corresponding risk assessment methodologies;

(e) Lack of reliable data on background variability or baseline conditions for several assessment end points (e.g. lack of access to data, poor data quality, fragmented data sources, inconsistent use metadata);

(f) Limited number of analytical tools for quantifying the effects of living modified organisms on relevant assessment and measurement end points;

(g) Limited capacity and resourcing poses challenges for national implementation.

255. In outlining the complexity of addressing operationalization of protection goals, there was a view during the online forum that risk assessment frameworks may fail to incorporate social dimensions, such as gender mainstreaming and considerations of indigenous peoples and local communities. It was noted that there is a lack of gender-disaggregated data in environmental contexts and limited institutional capacity to translate protection goals into measurable gender-sensitive end points. Furthermore, it was mentioned that quantifying values that are culturally or spiritually important to indigenous peoples and local communities is difficult. However, incorporating stakeholder participation could assist in understanding the relevance of particular protection goals, assessment end points and measurement end points.

D. Specific issues concerning operationalizing protection goals into relevant assessment and measurement end points

1. Potential to cause adverse effects on biodiversity

256. Assessment end points are important elements to understand the protection of biodiversity from the potential adverse effects of living modified organisms, as well as for informing environmental monitoring and surveillance. It was also suggested that the operationalization of protection goals assists Parties in identifying and prioritizing species and ecosystems to be considered in biodiversity monitoring frameworks.

2. Introduction into the environment

257. Assessment end points are considered essential in understanding the risks that may be posed by the intentional introduction of living modified organisms in the environment through determining plausible pathways to harm.

3. Dissemination across national borders

258. Operationalizing protection goals into assessment end points may also support regional cooperation activities related to risk assessment, especially if there could potential adverse effects on species or habitats protected at a regional level.

4. Commercialization status of living modified organisms

259. The operationalization of protection goals into relevant assessment end points could be applicable to all living modified organisms, whether commercialized or not.

E. Existing resources on similar issues

260. One of the submitting Parties and participants of the online forum noted that this topic was addressed in the voluntary *Guidance on risk assessment of living modified organisms and monitoring*

in the context of risk assessment[56] and *Additional voluntary guidance materials to support the case-by-case assessment of living modified organisms containing engineered gene drives*,[57] as well as the guidance documents published by the European Food Safety Agency[58] and the Organisation for Economic Cooperation and Development[59].

261. Regarding the gender-specific elements, several resources were shared that could provide useful guidelines or could be adapted for this specific topic of risk assessment, including the Gender Plan of Action,[60] the *Gender and Rural Advisory Services Assessment Tool*,[61] *Global Gender and Environment Outlook*[62] and the *Toolkit for Mainstreaming and Implementing Gender Equality 2023*.[63]

262. During the online discussions, there was a view that the lack of documentation of national approach represents a missed opportunity to demonstrate national contributions to the objectives of the Protocol and the Convention, particularly with regard to safeguarding biodiversity through robust risk assessment and long-term monitoring of living modified organisms. Thus, it was suggested that a compilation or survey (e.g. case studies, best practices or lessons learnt) of the various approaches currently taken could be useful resource that Parties can use to develop specific assessment end points specific for their national circumstances. It was suggested that headline indicators for each protection goal or assessment end point should also be included to serve as a baseline or matrix for adaptation by interested Parties.

XIV. Simplified procedures (Article 13 of the Protocol) and agreements and arrangements (Article 14)

263. Two Parties indicated that simplified procedures (Article 13 of the Protocol), and bilateral, regional and multilateral agreements and arrangement (Article 14) was a priority topic of risk assessment.

264. During the discussions of the online forum, it was noted that elements of this topic could also related to the topic "Transportability of data for risk assessment of living modified organisms".

A. Relationship to the scope of the Cartagena Protocol on Biosafety

265. During the discussions of the online forum, it was shared that the typical practice to obtain a regulatory authorization is for the developer to submit an application to the competent regulatory authority, which then assesses the application and makes a decision. The application addresses the notification requirements (Article 8) and the regulatory data required by the authority to inform the risk assessment (Article 15, Annex III). The application is then utilized as the basis for making a decision (Article 10). This process applies to the first transboundary movement of the living modified organism for intentional introduction into the environment and constitutes the advance informed agreement procedure (Article 7).

266. In their submissions, the submitting Parties indicated that the topic relates to the scope of the Protocol, which seeks to ensure an adequate level of protection in the safe transfer, handling, and use

[56] UNEP/CBD/BS/COP-MOP/8/8/Add.1.
[57] CBD/CP/MOP/11/9.
[58] European Food Safety Authority (2016) Guidance to develop specific protection goals options for environmental risk assessment at EFSA, in relation to biodiversity and ecosystem services. *EFSA Journal*, vol. 14, 6 (June)
[59] Organisation for Economic Co-operation and Development. (2023). *Safety Assessment of Transgenic Organisms in the Environment, Volume 10: OECD Consensus Document on Environmental Considerations for the Release of Transgenic Plants, Harmonisation of Regulatory Oversight in Biotechnology*. Paris: OECD Publishing.
[60] Decision 15/11.
[61] Food and Agriculture Organization of the United Nations (2016) Gender and Rural Advisory Services Assessment Tool (GRAST), Brochure. Rome, Italy.
[62] United Nations Environment Programme (2016) Global Gender and Environment Outlook. Report. Nairobi, Kenya.
[63] Organisation for Economic Co-operation and Development (2023) *Toolkit for Mainstreaming and Implementing Gender Equality 2023*, OECD Publishing, Paris, France.

of living modified organisms, while allowing simplified procedures (Article 13) and bilateral, regional, and multilateral agreements (Article 14), when appropriate. It was suggested that such procedures and arrangements would allow Parties to focus on new scientific cases and information, while acknowledging the experience using living modified organisms to date. It was further suggested that this topic aligns with Goal A.4 (Parties are in compliance with the requirements of the Protocol) of the Implementation Plan for the Cartagena Protocol on Biosafety,[64] could contribute to Target 17 of the Kunming-Montreal Global Biodiversity Framework and could foster responsible trade and research.

267. Some participants of the online forum noted two cases in which simplified procedures may apply. The first being when an intentional transboundary movement occurs at the same time as the notification and the second being when imports of living modified organisms are exempted from the advance informed procedure. It was emphasized by participants of the online forum in both cases the Party of import should apply adequate measures to ensure the safe intentional transboundary movement of living modified organisms in accordance with the objective of this Protocol. For the case of the concurrent transboundary movement and notification, the information provided in the notification would be in line with the information specified in Annex I, which in turn requires a risk assessment report consistent with Annex III. However, for the second case, it was suggested by some participants that it may only operate at a domestic level (i.e. restricted to a specific importing Party) and transboundary movements of the same living modified organism to other Parties would still require adherence to both Annex I and Annex III.

268. During the online discussions, some participants questioned the relationship of this topic to Article 15, Article 16 and Annex III. They noted that that scope of the process outlined in Annex I to decision CP-9/13 was specific to Articles 15 and 16 of the Protocol, while the identified topic relates instead to Article 13, Article 14 and Annex I.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

269. For topic of Simplified procedures (Article 13 of the Protocol) and agreements and arrangements (Article 14), it was suggested that the challenge relates to creating an enabling environment that maximizes for the potential benefits of modern biotechnologies, while recognizing the history of use of living modified organisms.

270. It was noted that current frameworks generally focus on assessment at the individual level and on a case-by-case basis. But, to date, there have not been any specific and internationally agreed guidelines or a structured methodological framework to systematically identify categories of living modified organisms that could be subject to simplified procedures. However, it was also mentioned that Annex I to the Protocol provides the necessary information, taking risk assessments conducted in line with Annex III to the Protocol into account. It was also emphasized that Annex III would provide guidance for the applications of both Articles 13 and 14.

271. It was suggested that experience gained from assessing several traits or events and multiple assessments of the same living modified organism could be a basis for information sharing to support the implementation of Article 13. Examples mentioned could include leveraging previous assessment to reduce regulatory redundancy (e.g. new assessments of well-characterized traits could rely on previous data instead of requiring new complete assessments) and streamlined reassessment (e.g. risk assessment could rely on existing data and only require country-specific studies to evaluate specific risk hypotheses for living modified organisms that have been approved in multiple regions and monitored for years without adverse effects).

272. Depending on the interpretation, it was also noted that simplified procedures in line with Article 13 could potentially bypass a full risk assessment. These procedures may also result in reduced traceability and transparency. Thus, the notification to the Biosafety Clearing-House was

[64] CBD/CP/MOP/DEC/10/3.

emphasized as being critical for information sharing regarding any arrangements and sharing information related to this topic.

C. Challenges in addressing the specific issue

273. The specific challenges of this topic relate to:

(a) Defining a simplified procedure with regard to Article 13 and the essential mandatory elements for agreements with regard to Article 14 that are consistent with the objectives of the Protocol while avoiding regulatory ambiguity;

(b) Establishing the evidence-based thresholds for the specific living modified organisms or traits that could qualify for simplified procedures;

(c) Establishing standardized and robust scientific criteria that can be used to identify categories of categories of living modified organisms with low-risk potential;

(d) Developing an approach that is flexible enough to be adapted to different ecological contexts and consistent across multiple countries;

(e) Balancing the simplification of procedures on the basis of familiarity with the need for rigorous scientific assessments of new cases;

(f) Establishing mechanisms to efficiently share information between countries with regulatory experience and those with developing systems;

(g) Ensuring a sufficient standard of protection with respect to bilateral, multilateral and regional mechanisms (e.g. oversight mechanisms, harmonization with international standards);

(h) Ensuring the proper implementation of risk management measures and the prevention of unintended or unauthorized uses of living modified organisms.

274. Further, it was suggested that one specific challenge may relate to an increased workload on competent national authorities, which may need to manage multiple procedural pathways and determine which regulatory pathways a living modified organism would be subjected to. The complexity may also hinder effective risk management and post-assessment monitoring.

275. It was also shared that scientific models could be further developed to:

(a) Characterize categories of living modified organisms according to survival, establishment and dissemination parameters, which could be measured with standardized models;

(b) Evaluate the likelihood of establishment and persistence based on the history of previous use;

(c) Develop robust, simplified methods to assess the expected behaviour following deliberate or accidental releases;

(d) Develop valid extrapolation methods based on existing data from releases in similar environments;

(e) Establish methodologies to transfer knowledge about the behaviour of categories of living modified organisms between regions with comparable ecological characteristics.

276. During the discussions of the online forum, there was a view that simplified procures would still depend on adequate pre-release processes to confirm that the particular living modified organism was as intended, was a hazard equivalent to a non-modified organism, and was of an acceptable risk in the intended receiving environment. On this basis, some participants suggested that a solution might already exist in the methodology contained in Annex III to the Protocol.

277. Practical examples that may contribute to resolving of the indicated challenges may include harmonizing the treatment of stacked events, the transportability of data related to risk assessments of living modified organisms, defining pre-approved categories of living modified organisms (e.g.

those that have well-characterized traits or events, those that have received regulatory approval in multiple jurisdictions, those that have modifications found in the plant pan-genome) and the use of regional risk assessments (e.g. MERCOSUR, ASEAN, African Union).

D. Specific issues concerning simplified procedures (Article 13 of the Protocol) and agreements and arrangements (Article 14)

1. Potential to cause adverse effects on biodiversity

278. The submitting Parties indicated that the topic would relate to those living modified organisms that have already received commercial approval and have been extensively cultivated for long periods of time without causing adverse effects on biodiversity. It was further mentioned that the process builds upon and utilizes previous risk assessments, particularly for those living modified organisms for which comprehensive data and a history of safe use exist.

279. During the discussions of the online forum, some participants further complemented the information by Parties, suggesting that by exempting certain living modified organisms in line with the provisions of Article 13 would allow for the effective allocation of resources. Parties could then focus on measures to control the introduction of living modified organisms that are not exempted and may pose risks, such as further developing risk management measures.

280. There was also a view that simplified procedures could result from unintended or unauthorized uses of living modified organisms and that bilateral, multilateral and regional agreements in line with Article 14 could vary in stringency and potentially resulting in uneven levels of protection of biodiversity. Thus, it was mentioned that both simplified procedures or lenient agreements could overlook risks specific to vulnerable ecosystems, rare or endemic species, unique habitats or impacts on human health, particularly for indigenous peoples and local communities, women and rural communities.

2. Introduction into the environment

281. Living modified organisms that are subjected to simplified procedures and/or bilateral, multilateral and regional agreements would be introduced into the environment.

3. Dissemination across national borders

282. The proposed topic could enable countries to establish guidelines for simplified procedures. It was suggested that the evaluation of cross-border dissemination could benefit from the implementation of Article 13, allowing for a clear distinction between living modified organisms exempted from advance informed agreement and those not exempted, as well as facilitating the adoption of the most appropriate emergency measures.

283. During the discussions of the online forum, it was mentioned that agreements in line with Article 14 could facilitate an increased number of transboundary movements, which may lead to unintended spread of living modified organisms in the environment.

4. Commercialization status of living modified organisms

284. According to the submissions, to be considered as a living modified organism exempted from advance informed agreement and covered under the scope of Article 13, the particular living modified organism would need to be commercialized and received multiple regulatory approvals from different agencies globally. The living modified organisms should also have been cultivated in millions of hectares and consumed by a great quantity of people over many years depending, as appropriate.

E. Existing resources on similar issues

285. An example from the Organisation for Economic Co-operation and Development[65] that highlighted the collaborative work on safety assessments and simplified procedures was shared during the online discussions. The document highlighted initiatives undertaken in Canada, New Zealand, South Asia and the Economic Community of West African States.

286. One of the submitting Parties indicated that regulatory frameworks with simplified procedures, risk assessment dossiers and technical publications already exist and could be reviewed to support the development of any guidance on the topic. It was suggested that case studies of well-characterized crops (e.g. crops expressing *Bacillus thuringiensis* crystal proteins or crops modified for herbicide tolerance) could be valuable examples and could validate any proposed models.

287. The other submitting Parties submitting noted that the following resources could be adapted: the consensus documents published by the Organisation for Economic Co-operation and Development, the concept of familiarity in international regulatory bodies, risk categorization frameworks and decision-making tools used by countries with well-established regulatory systems, simplified protocols considered by regional organizations (e.g. ASEAN, COMESA), and centralized databases used for information sharing (e.g. the Biosafety Clearing-House).

288. During the discussions of the online forum, it was suggested that a guidance related to this topic could assist with the description of specific categories of living modified organisms and with the identification of relevant experience. In addition, it was suggested that experience from Parties that have incorporated regulations on simplified procedures within their regulatory systems and regional collaborations on risk assessment could serve as case studies. Furthermore, it was emphasized that any guidance on simplified procedures would need to be based on Annex III to the Protocol and promote greater notification to the Biosafety Clearing-House.

289. There was also a view that guidance related to Articles 13 and 14 should provide scientific methods to (a) efficiently estimate the likelihood or adverse impacts based on previous data, (b) identify predictive factors that could serve as indicators for potential risks to enable tiered approaches, (c) develop protocols to assessment impacts on non-target keystone species in each region, (d) establish clear technical criteria to determine when comprehensive assessment or simplified procedures are required, (e) allow for the incorporation of local and traditional scientific knowledge into rapid assessment, (f) categorize living modified organisms according to their transboundary dispersal and establishment, (g) provide predictive models to allow neighbouring countries to collaborate on risk assessments, (h) establish technical criteria to determine when bilateral or regional agreements are justified according to Article 14, (i) facilitate harmonized approaches that allow for joint assessments between countries, and (j) provide standardized methods to share and recognize data from previous assessments conducted under similar conditions.

XV. Transportability of data for the risk assessment of living modified organisms

290. One Party indicated transportability of data for the risk assessment of living modified organisms as a priority issue for risk assessment.

291. The concept is based on utilizing data from confined field trials of living modified organisms for environmental risk assessment in countries other than those where the field trials were conducted. The data collected is often an agro-phenotypic characterization, which assesses the presence of any unintended or adverse effects that could potentially be caused by the modification and then is utilized to inform the environmental risk assessment.

[65] Organisation for Economic Co-operation and Development (2023) Considerations for Collaborative Work on the Safety Assessments of Foods and Feeds Derived from rDNA Plants. Environment Directorate. ENV/CBC/MONO(2023)37.

292. During discussions of the online forum, it was suggested that this topic could be considered as a solution rather than challenges as improved transportability of data could enhance efficiency, reduce duplications of efforts, support regulatory cooperation and strengthen risk management aspects without compromising biosafety.

293. Some participants noted shared elements with the risk assessment topic of Simplified procedures (Article 13 of the Protocol) and agreements and arrangements (Article 14).

294. In their submission, it was mentioned that this topic aims to seek a balance between fostering an enabling environment for innovation and ensuring safety, while reducing the amount of data that needs to be presented. This could potentially benefit public sector developers with limited funding, especially those focused on subsistence farmers, as well as facilitate regulatory approvals in countries where the market might not justify the expenses with new field trials, such as regions with low crop production, ultimately benefiting local communities.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

295. In their submission, the Party indicated that there are decades of experience and an accumulation of knowledge and information related to conducting risk assessments of living modified organisms. It was suggested that this topic aligns with the scope of the Protocol as it relates to ensuring an adequate level of protection of biodiversity, while also providing an opportunity to update regulatory frameworks of Parties to the Protocol.

296. During the discussions of the online forum, it was mentioned that this topic relates to Annex III to the Cartagena Protocol. It was also noted that the Protocol prevents an importing country from considering the data developed in another jurisdiction.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

297. In the submission by the Party and during the online forum, it was noted that current regulatory frameworks often restrict the transportability of data. Thus, data collected in previous confined field trails is often not utilized during risk assessments in other countries. The particular challenge in adopting data transportability for environmental risk assessment lies in establishing a defined procedure that enables an evidence-based process, while providing scientifically sound justification to allow the use of data from another country by local regulators.

298. Clear guidelines regarding data requirements could assist regulators in making informed decisions about whether data from previous confined trials can support a risk assessment in a new country. It was suggested that this could have the potential to reduce regulatory review times and, consequently, shorten the time needed to deliver desired varieties to producers.

299. With regard to the above, the challenges related to the transportability of data were noted as being related to:

(a) Data and its re-use;

(b) Local contexts;

(c) Interoperability between databases;

(d) Regulation;

(e) National capacities.

300. During the discussions of the online forum, it was emphasized that there would still be a requirement to meet the obligations according to Annex III to the Protocol. There were also diverging views on whether a weight-of-evidence approach would be applicable to address some challenges related to the transportability of data, as it may not be clear how uncertainties, gaps in knowledge and the need for further data would be addressed.

301. One suggestion was to address the challenges included further strengthening the infrastructure of the Biosafety Clearing-House to enhance scientific collaboration and regulatory efficiency. Examples shared included promoting regional data sharing and exchange with the Biosafety Clearing-House, adopting global data standards for further interoperability, capacity-building on data infrastructure and the Biosafety-Clearing House and enhancing machine readability on the Biosafety Clearing-House.

302. Other proposed solutions included the use of comparative risk assessment frameworks for determining the relevance and reliability of foreign data, the use of bridging studies to supplement foreign data with local evidence, the promotion of mutual recognition mechanisms, guidelines and the production of data under varying environmental contexts (e.g. use of harmonized criteria), the use of robust laboratory studies to collect controlled data to inform risk assessments (e.g. production with good laboratory practices or international standards in accredited laboratories) and memoranda of understanding between countries to promote information-sharing.

C. Challenges in addressing the specific issue

303. The specific challenges raised in relation to the transportability of data for risk assessment of living modified organisms were related to:

(a) Data and its re-use;

(b) Inconsistent use of standardized formats when submitting data (e.g. incomplete data, non-machine-readable data, inconsistent ontology for traits):

(i) Inconsistent data quality (e.g. robustness, applicability, repeatability);

(ii) Environmental and ecological variability (e.g. soil types, climate, altitude, native species, abiotic responses of the living modified organism) affects on the relevance of the data;

(iii) Lack of guidance on how foreign data could be accepted or adapted;

(iv) Limited access to data from originating countries or developers (e.g. intellectual property or confidentiality concerns, ownership of data limits sharing);

(v) Limited evidence demonstrating the applicability of the concept to comprehensively cover all risks to biodiversity;

(c) Local contexts:

(i) How to address the need for consideration or adaptation in local receiving environments (e.g. in line with paras. 5, 8 and 9 of Annex III);

(d) The interoperability between databases:

(i) Lack of integration between the Biosafety Clearing-House and national databases could limit portability across jurisdictions;

(e) Regulation:

(i) Limitations on the re-use of data due to differences in regulatory requirements and level of details required;

(ii) Lack of legal mandates for data standardization (e.g. Protocol does not require adherence to data interoperability standards, lack of trait ontology standardization);

(iii) Requirement for locally conducted agronomic studies in some jurisdictions;

(f) National capacities:

(i) Limited technical and institutional capacity (e.g. countries may underreport, which could limit regional harmonization);

(ii) Limited available expertise or local capacity to evaluate the applicability of foreign data.

304. It was mentioned that using structured approaches based on risk hypotheses and problem formulation would allow for the identification of gaps in data or whether the data could be applicable to the local context or require local data collection. It emphasized that datasets should be sufficiently representative, robust and relevant such that they could be extrapolated for different contexts.

305. Some participants of the online forum noted that studies have been conducted in which data was collected across multiple locations with varying environmental conditions and no biologically relevant differences were observed between the living modified organism and non-modified recipient/parental organism. They suggested that such data could be utilized for risk assessment in another jurisdiction and thus did not consider environmental variability to be a large challenge. However, some other participants noted scientific studies demonstrating significant impacts of both biotic and abiotic factors on various organisms, such as plants.

D. Specific issues concerning transportability of data for the risk assessment of living modified organisms

1. Potential to cause adverse effects on biodiversity

306. In general, the potential adverse effects on biodiversity would be specific to a particular living modified organism and can be identified through the formulation of risk hypotheses.

307. Data produced outside the local context would then need to be assessed to understand whether it would be applicable in the local context. For example, regarding impacts on non-target organisms, the use of ecological equivalent surrogates may provide information on the applicability of data. It was further suggested that beyond a "core" set of data related to weediness/invasiveness potential, the potential for and effects of transgene flow, and the potential adverse effects on beneficial non-target organism populations, additional local data should be considered on a case-by-case basis and guided by problem formulation in the context of the receiving environment.

308. During discussions of the online forum, some participants emphasized that relying on data inappropriate for Annex III could result in adverse effects on biodiversity, human health and the value of biodiversity to indigenous peoples and local communities, particularly if the original data did not capture a region-specific concern (e.g. an endemic species). Furthermore, data collected in different climate zones may not accurately reflect the potential risks of a living modified organism in its local receiving environment.

2. Introduction into the environment

309. The availability of guidelines for the transportability of data could assist Parties in making informed decisions regarding the intentional introduction of living modified organisms into the environment. Clear procedures and criteria for utilizing data from confined field trials in the context of a risk assessment for an introduced living modified organism could also assist with establishing the most appropriate management measures to address emergency situations as well.

310. During discussions of the online forum, it was suggested that the transportability of data may result in an increase of introductions into the environment without potentially considering the local risks sufficiently or establishing appropriate safeguards.

3. Dissemination across national borders

311. The proposed topic seeks to enable countries to establish guidelines for the transportability of data. In this context, evaluating a scenario of dissemination across national borders could benefit from guidelines that define procedures for allowing data from trials conducted in similar climates and agricultural conditions to be deemed relevant and sufficient to meet regulatory requirements.

This approach could potentially streamline approval processes, thereby reducing delays in the synchronization of regulatory approvals of living modified organisms and mitigating the risk of unauthorized living modified organisms spreading across borders.

312. During discussions of the online forum, it was suggested that the transportability of data may result in increased transboundary movements of living modified organisms.

4. Commercialization status of living modified organism

313. The transportability of data applies to living modified organisms that have already received commercial approval in certain countries and are subsequently submitted for risk assessment in other countries.

E. Existing resources on similar issues

314. The submitting Party noted that regulatory frameworks with simplified procedures, risk assessment dossiers and scientific publications that could be reviewed to develop guidelines for this proposed topic. However, the Party did not identify any existing resource that could be adapted for use.

315. Participants of the online forum mentioned Annex III to the Protocol as an existing resource.

316. The publication *Data Transportability for Studies Performed to Support an Environmental Risk Assessment for Genetically Modified Crops*[66] was shared as being particularly relevant for this topic by several members of the online forum.

317. It was also noted that authorities, such as those in the European Union, Japan, Australia, Brazil, among others, have accepted foreign field and laboratory data when they meet defined criteria for quality, relevance and scientific justification regarding the risk assessment of living modified organisms. It was suggested that these could provide examples of how data can be integrated into a risk assessment.

XVI. Use of living modified organisms in centres of origin and in traditional agricultural systems

318. Two Parties indicated that the need for guidance on use of living modified organisms in centres of origin and in traditional agricultural systems.

319. During the online forum, there was the view that clearly defining and operationalizing protection goals into relevant assessment and measurement end points would be important to consider in the context of this proposed topic.

A. Relationship to the scope of the Cartagena Protocol on Biosafety

320. In their submission, the submitting Parties indicated that the topic is aligned with the objective of the Cartagena Protocol, which aims to ensure the handling, transport and use of living modified organisms that may have adverse effects on the conservation and sustainable use of biological diversity, taking into account human health. The topic relates to the need to conserve genetic resources and prevent transboundary impacts. It was suggested that this could be more acute in centres of origin, megadiverse countries or in traditional or informal agricultural settings.

B. Challenges to existing risk assessment frameworks, guidance and methodologies

321. In current risk assessment frameworks, it was noted that they have been primarily designed for formal and regulated agricultural systems. Thus, there might be limited potential to assess the risks of living modified organisms in informal or traditional agricultural settings, where small-scale farmers may not have access to technical support, participate in exchanges of uncertified seeds,

[66] Such as Bachman and others (2021) Data Transportability for Studies Performed to Support an Environmental Risk Assessment for Genetically Modified (GM) Crops. *Journal of Regulatory Science.* vol. 9, 1.

facilitate cross-border movements of seeds, which could then introduce additional potential risks not normally considered. These frameworks may also not account for the heterogeneity of agricultural practices utilized by all farmers.

322. For certain countries, which are megadiverse and/or centres of origin for crop species, the use or introduction of living modified organisms could create co-existence between the native and the modified varieties. This co-existence could participate in complex ecological interactions or pose unique risks that are difficult to assess using conventional risk assessment frameworks. Furthermore, some of these ecosystems are poorly studied. Megadiverse countries also have complex and sensitive ecosystems, which may additionally necessitate the development and application of risk assessment approaches that are specifically tailored to their unique characteristics.

323. Participants of the online forum also indicated that conventional risk assessments may not fully account for the unique ecological, genetic and cultural sensitivities of centres of origin and traditional agricultural systems. In this context, it was also noted that sociocultural considerations are often not accounted for in current risk assessment frameworks, guidance and methodologies, which could be important with regard to this proposed topic. It was suggested that the full and effective participation of indigenous peoples and local communities in the risk assessment process could contribute to addressing this problem.

324. Annex III to the Protocol was emphasized as being important to ensure that risk assessments are conducted in a scientifically-sound and case-by-case manner. The problem formulation approach was also suggested as being sufficiently robust to evaluate the potential risks of using living modified organisms in centres of origin and in traditional agricultural systems.

C. Challenges in addressing the specific issue

325. The specific challenges related to this topic could potentially include:

(a) Lack of incorporation of local contexts in global risk assessment frameworks;

(b) High diversity of non-target organisms, wild relatives or traditional varieties may make assessing the interactions with and responses to living modified organisms challenging as they can be poorly understood or studied;

(c) Lack of baseline data on wild relatives and traditional varieties, especially in megadiverse countries;

(d) Limited previous consideration for genomic plasticity in centres of origin;

(e) Lack of accessible tools to measure hybridization and its impacts on genetic diversity;

(f) Limited consideration of gene flow in traditional agricultural systems and centres of origin;

(g) Diverse and heterogeneous agricultural practices can hinder a standardized approach to conducting risk assessments;

(h) Lack of consideration of the intangible value of agrobiodiversity for indigenous peoples and local communities;

(i) Lack of integration of ancestral and traditional knowledge systems into risk assessment;

(j) Inability to detect illegal transboundary movements;

(k) Challenges from informal and remote rural markets leading to releases of unauthorized living modified organisms;

(l) Lack of reliable data for unauthorized releases;

(m) Traceability and monitoring of living modified organisms can be challenging in informal systems;

(n) Limited access to information for small-scale or rural farmers, who may not be aware of biosafety regulations and associated biosafety measures.

326. For the use of genome-edited crops in centres of origin and in traditional agricultural settings, it was suggested that there is a lack of knowledge with regard to how the modification affects cellular function and gene expression, as well as how edited sequences interact in the environment (e.g. with the transgenic sequences from potential living modified organisms present and non-modified organisms).

D. Specific issues concerning the use of living modified organisms in centres of origin and in traditional agricultural systems

1. Potential to cause adverse effects on biodiversity

327. It was suggested that use of living modified organisms in centres of origin and in traditional agricultural systems may cause the following adverse effects on biodiversity:

(a) Reduced adaptation of species to its environment resulting from gene flow;

(b) Disrupted interactions with associated organisms as a result of gene flow;

(c) Reduction in genetic diversity (e.g. threaten landrace integrity, reduce pool of potential genes for future use);

(d) Reduction in agrobiodiversity;

(e) Adverse effects to beneficial organisms, which may have not been assessed in the context of centres of origin or in traditional or informal agriculture settings.

328. Regarding indigenous peoples and local communities and women, it was suggested that there could be socioeconomic or cultural impacts, as these groups depend on traditional crops, rely upon traditional practices (e.g. farming practices, seed saving) and operate within market systems that require products free of living modified organisms. Furthermore, a participant raised the potential for conflicts with cultural and ethnic groups, such as over food sovereignty and biocultural heritage, the potential loss of associated traditional knowledge.

329. During the online forum, it was also mentioned that current liability and redress mechanisms were unclear in relation to traditional crops and practices.

2. Introduction into the environment

330. Within the context of this topic, accidental introduction into the environment can potentially occur through intentional international trade or the unintentional selling and purchasing of living modified seeds in informal market settings without the knowledge of the farmers. It may also occur when the use of particular living modified organisms can change (e.g. living modified organisms for feed are cultivated in the environment) or during aid-related distribution.

331. For deliberate releases, it was noted that living modified seeds are being purchased and planted in unauthorized areas.

3. Dissemination across national borders

332. In their submission, one Party noted that transboundary movements may occur due to regional regulatory asymmetries and informal cross-border trading. Participants of the online forum also noted the potential for transboundary movements resulting from gene flow, particularly in regions with shared ecosystems or agricultural practices, or form human activities.

333. There was a suggestion that regional cooperation mechanisms and transboundary monitoring protocols might be needed to mitigate shared risks.

4. Commercialization status of living modified organism

334. It was noted that many living modified organisms are commercialized and traded globally. Despite this, one submitting Party noted that reports are available regarding the unauthorized cultivation of living modified organisms within their territory.

335. During the discussions of the online forum, it was noted that certain commercialized crops (e.g. maize, cotton, rice) have been proposed for cultivation in their centres of origin.

E. Existing resources on similar issues

336. One submitting Party noted that the procedures, guidelines and regulatory frameworks for risk assessment would need to be reviewed and adapted to take high biodiversity, informal agricultural systems and transboundary considerations into account.

337. It was suggested that any guidance developed can use case studies of risk assessments conducted in countries that are centres of origin or have a high diversity of domesticated species to allow for a detailed analysis of the methodologies applied, the obstacles encountered during the process and the strategies implemented to overcome these challenges. The lessons drawn from these practical examples could be valuable for informing the development of more effective risk assessment frameworks that are tailored to the realities of countries with informal agricultural sectors and/or those considered as megadiverse.

XVII. Other elements raised

338. One Party identified risk assessment itself as a priority. In their submission, the submitting Party recalled the objective of the Protocol as specified in Article 1 and the need to ensure an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms. They noted the need for capacity strengthening to improve their understanding of the concepts and provisions on the risk assessment of living modified organisms. It was suggested as important because the deliberate or accidental environmental release of living modified organisms may have the potential to become invasive, which could displace native flora and fauna that may hold importance for indigenous people and local communities.

339. During the online discussions, several participants suggested various elements that could be considered in relation to the needs and priorities identified by Parties. These included:

(a) The need for capacity-building and development to improve the understanding of best practices when conducting risk assessments, how to apply existing resources and access relevant information;

(b) The development of technical notes, which focus on key consideration rather than full guidance documents (e.g. potential for horizontal gene transfer in microorganisms, welfare considerations in animals, ecosystem interactions in algae and fish);

(c) Providing additional information on risk management strategies;

(d) Providing information related to mechanisms for post-approval monitoring and feedback, which would promote a dynamic and iterative risk assessment processes that can be refined over time and generate new data;

(e) The need to take the precautionary approach, Article 16 of the Cartagena Protocol, Articles 8(g), 8(j) and 10 of the Convention on Biological Diversity and existing voluntary guidance that has been developed under the Convention and its Protocols into account;

(f) The applicability of the structured analysis set out in decision CP-9/13 and some of the proposed topics.

Annex

Template for submitting detailed information by Parties pursuant to paragraph 8 of decision CP-11/7

Part I. Endorsement of submission

Name of Country:	
Name of Cartagena Protocol Focal Point:	
Endorsement signature of Focal Point:	
Date:	

Part II. Submission of information

1. The Conference of the Parties serving as the meeting to the Parties to the Cartagena Protocol on Biosafety, in paragraph 6 of decision CP-9/13, decided to establish a process for the identification and prioritization of specific issues regarding risk assessment of living modified organisms for consideration by the Conference of the Parties serving as the meeting of the Parties to the Cartagena Protocol with a view to developing further guidance on risk assessment on the specific issues identified. Annex I to that decision contains a structured analysis to evaluate whether particular topics, priority areas or issues fulfil specific criteria.

2. In their recent decision CP-11/7, the Conference of the Parties serving as the meeting to the Parties to the Cartagena Protocol on Biosafety invited Parties to submit information on their needs and priorities for further guidance materials on specific topics of risk assessment of living modified organisms, including a rationale following the criteria set out in annex I to decision CP-9/13.

3. Based on the above, please submit information by completing the table template on the following page. As needed, more than one topic, priority area or issue may be submitted. However, kindly complete one table template per topic, priority area or issue. Parties may also wish to re-submit topics from previous intersessional periods if they remain a priority.

4. When uploading information to the Biosafety Clearing-House using the submissions (SUB) common format, kindly include all files (i.e. all submissions) in one SUB record as a single submission.

1. Specific topic, priority area or issue of risk assessment:
2. Indicate how the topic, priority area or issue falls within the scope and objective of the Cartagena Protocol:
3. Describe how the topic, priority area or issue poses challenges to existing risk assessment frameworks, guidance and methodologies, for example, if the issue at hand has been assessed with existing risk assessment frameworks but poses specific technical or methodological challenges that require further attention:
4. Clearly describe the challenges in addressing the specific issue:
5. Describe the specific issues related to the potential to cause adverse effects on biodiversity, in particular those that are serious or irreversible, taking into account the urgent need to protect specific aspects of biodiversity, such as an endemic/rare species or a unique habitat or ecosystem, taking into account risks to human health and the value of biological diversity to indigenous peoples and local communities:
6. Describe the specific issues that are related to either the deliberate or accidental introduction into the environment:
7. Describe the specific issues related to the potential to disseminate across national borders:
8. Indicate whether the living modified organism is already, or is likely to be, commercialized or in use somewhere in the world:
9. Describe if existing resources on similar issues have been developed by national, regional and international bodies and, if so, whether such resources may be revised or adapted to the objective of the Cartagena Protocol:
10. Related publications (Format: Authors (year), Title, Journal, DOI):