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CONSERVATION AND SUSTAINABLE USE OF MICROBIAL AND INVERTEBRATE BIOLOGICAL CONTROL AGENTS AND MICROBIAL BIOSTIMULANTS

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I. INTRODUCTION

1. At its Eighteenth Regular Session, the Commission on Genetic Resources for Food and Agriculture (Commission) welcomed the *Draft study on sustainable use and conservation of microbial and invertebrate biological control agents, and biostimulants*.¹ It requested FAO to finalize the study taking into account comments provided, publish it as background study paper and disseminate it.²
2. The Commission requested FAO to ensure that the findings of the study are taken into consideration in its work relevant to biological control agents (BCAs) and biostimulants, particularly with regard to restrictions on exchanges of BCAs and biostimulants, to knowledge gaps, research, education, training, funding, management and to the development and strengthening of policies and legal frameworks for the management of BCAs and biostimulants, and also to ensure that the work of relevant international initiatives and instruments, such as the International Organization for Biological Control and the International Plant Protection Convention, is taken into consideration. The Commission also invited countries to promote the sustainable management of BCAs and biostimulants and to ensure they are given due consideration in relevant local, national, regional and international policies and policy-development processes.³
3. The Commission requested the Secretariat, in order to maintain momentum in addressing the various functional groups of microorganisms and invertebrates, to collaborate with relevant expert groups in the drafting of recommendations for further consideration by the Commission.⁴
4. In response to the Commission's request, the draft study was finalized and published as Background Study Paper No. 71 *Sustainable use and conservation of microbial and invertebrate biological control agents and microbial biostimulants*.⁵
5. This document recalls the findings of Background Study Paper No. 71 and seeks the Commission's guidance on possible future work on microbial and invertebrate biological control agents and microbial biostimulants.

II. STATUS OF MICROBIAL AND INVERTEBRATE BIOLOGICAL CONTROL AGENTS AND MICROBIAL BIOSTIMULANTS

6. Microbial and invertebrate BCAs comprise microorganisms and invertebrates that induce an action against target organisms that cause harm to humans or their resources. Interest in their use is increasing as a result of concerns about the impacts of pesticide use and growing demand for products from biodiversity-friendly production systems. They contribute to all sectors of food and agriculture, but their deliberate use is most common in the crop and forest sectors.⁶
7. Biostimulants have been defined as “fertilising product[s] the function of which is to stimulate plant nutrition processes independently of the product's nutrient content with the sole aim of improving one or more of the following characteristics of the plant or the plant rhizosphere: (a) nutrient use efficiency, (b) tolerance to abiotic stress, (c) quality traits, or (d) availability of confined nutrients in the soil or rhizosphere”.⁷ They may strengthen plants' natural defences against pests and

¹ CGRFA-18/21/11.2/Inf.1.

² CGRFA-18/21/Report, paragraph 86.

³ CGRFA-18/21/Report, paragraphs 87 and 89.

⁴ CGRFA-18/21/Report, paragraph 93.

⁵ Buitenhuis, R., Cock, M.J.W., Colmenarez, Y.C., De Clercq, P., Edgington, S., Gadaleta, P., Gwynn, R., *et al.* 2023. *Sustainable use and conservation of microbial and invertebrate biological control agents and microbial biostimulants*. Background Study Paper No. 71. FAO Commission on Genetic Resources for Food and Agriculture. Rome, FAO. <https://doi.org/10.4060/cc3571en>

⁶ For further information and references on the issues discussed in this section of the document, see Background Study Paper No. 71.

⁷ du Jardin, P. 2015. Plant biostimulants: definition, concept, main categories and regulation. *Scientia Horticulturae*, 196: 3–14. <https://doi.org/10.1016/j.scienta.2015.09.021>; European Union. 2019. Regulation EU 2019/1009 of the European Parliament and of the Council of 5 June 2019 laying down rules on the making available on the market of EU fertilising products and amending Regulations EC No 1069/2009 and EC No 1107/2009 and repealing Regulation EC No 2003/2003. *Official Journal of the European Union*, L 170: 1–114. <http://data.europa.eu/eli/reg/2019/1009/oj>

diseases. The main groups of microbial biostimulants are plant growth-promoting rhizobacteria and arbuscular mycorrhizal fungi. They are attracting increasing attention as sustainable alternatives to synthetic inputs in crop production.

8. Natural biological control⁸ plays an important role in production systems throughout the world. There is evidence that the adoption of conservation biological control⁹ is increasing, although rates of uptake vary from region to region, with knowledge gaps reported to be an important barrier to further adoption.

9. Adoption of classical biological control¹⁰ is uneven across the countries and regions of the world, with well-developed programmes existing in Australia, Canada, New Zealand, South Africa, the United States of America and various European countries, and some successful programmes in other regions.

10. Adoption of augmentative biological control¹¹ has increased markedly over recent years. Constraints to its further adoption include restrictive regulatory measures and the lack of integration with other sustainable agricultural practices.

11. Microbial and invertebrate BCAs face a variety of threats. A lack of data makes it difficult to make firm statements about their status and trends, but for insects in general (a group that includes many BCAs) there are reports of population declines in many ecosystems.

12. Microbial and invertebrate BCAs are being harmed by unsustainable practices in the food and agriculture sector. It is likely that negative drivers such as land-use change and climate change are leading to local and potentially global extinctions of wild BCA species.

13. *In situ* conservation efforts targeting microbial and invertebrate BCAs are limited. Species used in classical or augmentative biological control are maintained through use, both via mass rearing in captivity and via various measures taken to ensure that released populations flourish in the areas targeted. However, wild source populations that harbour high levels of genetic diversity may be threatened. It can be assumed that these source populations benefit from *in situ* conservation measures targeting biodiversity in general (e.g. the establishment of protected areas), but there is little indication that protecting BCAs is a specific objective in such efforts. Additional research attention needs to be given to *in situ* conservation strategies for microbial and invertebrate BCAs.

14. *Ex situ* conservation measures for microbial BCAs need to be better coordinated and documented. Many microbial BCAs are maintained *ex situ* for research or for applied use in the field. In some cases, these organisms are put into secure long-term storage. However, strains are often lost, and there is no overall coordination. Comprehensive information on the range of organisms maintained and on their genetic diversity is not available. Efforts are needed to improve the status of public-service *ex situ* collections of microbial BCAs, particularly in the developing regions of the world. *Ex situ* conservation of invertebrate BCAs remains very limited because of the difficulties involved in maintaining invertebrates in *ex situ* conditions.

15. While mass rearing of invertebrate and microbial BCAs is widespread, genetic improvement remains largely confined to research. Options, such as genomic selection and combining breeding populations (to increase genetic diversity and potentially deliver hybrid vigour) are attracting some interest. Constraints to progress in the genetic improvement of invertebrate and microbial BCAs include regulatory restrictions and knowledge gaps.

⁸ Natural biological control is the suppression of populations of harmful species by living organisms (or viruses) that occurs without deliberate intervention by humans for this purpose.

⁹ Conservation biological control is a diverse set of practices that aim to preserve and enhance the activity of natural enemies to improve existing levels of pest control and thereby reduce the negative effects of harmful species.

¹⁰ Classical biological control is the deliberate importation, release and establishment of natural enemies in areas where they did not previously exist to reduce non-native invasive pest populations to less-damaging levels.

¹¹ Augmentative biological control is an approach in which natural enemies of pests or antagonists of pathogens are mass-reared under controlled conditions and released with the aim of temporarily suppressing arthropod pests or diseases.

16. The management of invertebrate and microbial BCAs is affected by a variety of policy and legal instruments at global, regional and national levels, including those in the fields of plant protection¹² and access and benefit-sharing. These can operate both as enablers and as disablers of effective action to improve the sustainable use and conservation of these organisms.

17. Biological control strategies are relevant to a wide range of policy goals, including many of the Sustainable Development Goals (SDGs), but they are often not mainstreamed into relevant policy frameworks. Potentially relevant policy areas include science, technology and innovation, education for stakeholders in the agrifood system, food safety, climate change, occupational health and safety, trade, biodiversity conservation and ecosystem restoration, and post COVID-19 recovery.

18. Numerous policy levers can potentially be used to promote more widespread adoption of biological control. Options include both soft policy measures (e.g. certification schemes and food-safety labelling) and hard policy measures (e.g. conditional financial assistance, more stringent maximum residue limits, pesticide taxes and substance bans). Crop insurance schemes can potentially help reduce the tendency for producers to opt for strategies based on heavy use of pesticides.

19. Important enabling factors for biological control include intergovernmental and other international collaboration, adherence to international regulations, well-funded research facilities and efficient procedures for their use, and effective training of biological control practitioners. Due attention needs to be given to the sharing of non-monetary benefits associated with the use of invertebrate and microbial BCAs.

III. OPTIONS FOR ACTION

20. Background Study Paper No. 71 presents ten specific recommendations, aimed mostly at national governments but in several cases also implying potential for action at intergovernmental level.

- The conservation of natural enemies for biological control in crops and natural habitats should be an explicit objective in international standards on good agricultural practices and stewardship of natural areas, and in national and international policies for integrated pest management.
- National and international measures should be taken to strengthen research, including public-sector research, on the taxonomy and use of BCAs and to improve collections and other services (e.g. training of PhD-level scientists) and infrastructure (e.g. laboratories and quarantine facilities) that support biological control.
- National and international measures should be taken to educate farmers and conservationists on the benefits of natural enemies and their management and to increase their participation in research and implementation in order to promote successful uptake of biological control.
- National and international measures should be taken to promote community science initiatives that would engage the general public in the study and conservation of natural enemies.
- National and international measures should be taken to improve knowledge of the negative effects of pesticides on natural enemies, and this knowledge should be made openly accessible to farmers.
- The conservation of habitats of natural enemy species for biological control of future non-native pest problems in other countries should be an explicit element of national and international measures to conserve biodiversity in agroecosystems and natural ecosystems. Conservation and sustainable use of natural enemies can be further formalized and applied through conservation biological control practices.
- Government authorities should adopt simplified measures for access to and exchange of BCAs or consider exemption of these activities from the scope of their access and benefit-sharing regimes.
- Governments should develop appropriate national regulatory systems for BCAs that encourage and support the development of new agents for classical biological control and

¹² For example, the International Plant Protection Convention's International Standard for Phytosanitary Measures 3, adopted in 2005: FAO. 2017. *ISPM 3. Guidelines for the export, shipment, import and release of biological control agents and other beneficial organisms*. Rome. <https://www.fao.org/3/j5365e/j5365e.pdf>

methods to enhance augmentative biological control. They should harmonize regulatory requirements and promote knowledge sharing at the international level to facilitate the development of effective biological control programmes.

- In considering future measures for conservation and use of genetic resources for food and agriculture, governments should consider a broad approach to the conservation and sustainable use of biodiversity, including access to knowledge and capacity building; components of such an approach will help improve the use and conservation of BCAs.
- Governments should encourage initiatives that educate the public on the benefits of biological control, including its role in protecting the food supply (SDG 2) and terrestrial ecosystems (SDG 15), improving health (SDG 3), promoting sustainable production and consumption (SDG 12) and combating climate change (SDG 13).

21. Action to strengthen the sustainable use and conservation of invertebrate and microbial BCAs and microbial biostimulants is needed in a range of technical and policy areas. Key examples are briefly discussed in the following subsections, highlighting potential opportunities for action by the Commission.

Conservation

22. Efforts to address threats to microbial and invertebrate BCAs, and to a lesser extent microbial biostimulants, and to promote conservation measures for them, are urgently needed. Microbial and invertebrate BCAs and microbial biostimulants can be expected to benefit from generic actions that lead to improvements in the conservation of the microorganism and invertebrate biodiversity found in and around production systems. However, some specific priorities can be identified. With regard to *ex situ* conservation of BCAs, there is a need to support efforts to improve coordination among culture collection organizations. Capacity to store whole microorganism communities (microbiomes) is providing new opportunities for *ex situ* conservation, and there is a need to ensure that microbial BCAs and biostimulants are adequately included in initiatives in this field.

Sustainable use

23. The uptake of microbial and invertebrate BCAs and microbial biostimulants in food and agriculture needs to be promoted. This is particularly the case in developing countries, where BCAs and biostimulants could have a substantial impact in terms of increasing productivity, reducing environmental degradation and improving safety. Promoting uptake will require a facilitating framework with respect to, *inter alia*, the state of knowledge, capacity, cooperation, policy and legislation. Despite progress at the research level, genetic improvement of BCAs has had little practical impact to date. Constraints related, *inter alia*, to access and benefit-sharing issues and to knowledge gaps need to be addressed.

Exchange

24. Ensuring efficient exchange of microbial and invertebrate BCAs, including internationally, is vital to the development and implementation of biocontrol practices. This appears to be a key area of concern for many stakeholders working in the biocontrol sector.

25. To date, relevant Commission activities in this field have included coverage of microorganism and invertebrate genetic resources in the *Elements to facilitate domestic implementation of access and benefit-sharing for different subsectors of genetic resources for food and agriculture – with explanatory notes*.¹³

26. The Commission will presumably wish to ensure that microbial and invertebrate BCAs and microbial biostimulants are adequately addressed in any future work related to the exchange of genetic resources. Suggestions for practical steps include the establishment of an interactive site via which importing and exporting countries could establish terms of exchange. The development of a multilateral framework specifically aimed at facilitating access to and use of microbial and

¹³ FAO. 2019. *ABS Elements: Elements to facilitate domestic implementation of access and benefit-sharing for different subsectors of genetic resources for food and agriculture – with explanatory notes*. Commission on Genetic Resources for Food and Agriculture. Rome. <https://www.fao.org/documents/card/en/c/CA5088EN/>

invertebrate BCAs and the sharing of benefits arising from their use could be considered, and the Commission could potentially consider what role it could play in this regard.

Knowledge gaps

27. Improvements to the management of microbial and invertebrate BCAs and microbial biostimulants require knowledge of their characteristics, their roles in the supply of ecosystem services, their risk status and distribution, the threats affecting them, techniques for their use and conservation, and trends in the adoption of practices involving their use. Research on the management of BCAs and biostimulants can potentially be facilitated via capacity development, promoting access to data and information, developing or strengthening policy and legal frameworks, and promoting collaboration among researchers and between researchers and other stakeholders.

28. Assessment and monitoring of genetic resources and biodiversity – both overseeing the collection, management and diffusion of data at global level and supporting action at country level – have traditionally been key Commission activities.

Capacity development

29. The critical lack of human and material resources for the identification and characterization of microbial and invertebrate BCAs and microbial biostimulants, especially those that provide natural or conservation biological control, needs to be addressed. Action is particularly required in tropical and subtropical areas. National policy and legal frameworks for the management of microbial and invertebrate BCAs and microbial biostimulants often need to be strengthened or better implemented. Awareness raising among policymakers and provision of guidance on the development of policies and legislation are needed.

30. The Commission has, over the years, developed or endorsed guidelines on various technical aspects of genetic resources management, mostly for animal and plant genetic resources and mostly covering aspects of conservation, characterization and breeding. It could potentially consider whether there is any need for such instruments or publications in the case of microbial and invertebrate BCAs and microbial biostimulants and whether it is in a position to address this need, including, as relevant, what kinds of collaborative partnerships with other organizations might be needed in this regard.

Knowledge diffusion

31. There is a need to promote the diffusion of knowledge about invertebrate and microbial BCAs and microbial biostimulants to those who need it.

32. Promoting the diffusion of knowledge related to genetic resources and biodiversity and their management is a major aspect of the Commission's work, whether via the outputs of global assessments, reporting on the implementation of global plans of action, the publication of guidelines or the operation of information systems such as the Domestic Animal Diversity Information System (DAD-IS)¹⁴ and the World Information and Early Warning System on Plant Genetic Resources for Food and Agriculture (WIEWS).¹⁵

33. The Commission could potentially consider what it could do in this regard for microbial and invertebrate BCAs and microbial biostimulants. At its last Session, the Commission noted the potential value of developing an inventory of BCAs and biostimulants used around the world, including information on source countries, and on countries, environments and production systems where they are used.¹⁶ Other options might include support for an online knowledge portal featuring items such as relevant national policy frameworks and metrics of biological control impacts, or more dynamic virtual communities of practice and associated multistakeholder innovation platforms. Existing tools for knowledge diffusion need to be taken into account and promoted, and options explored for collaboration with other organizations working in the field.

¹⁴ <https://www.fao.org/dad-is/en>

¹⁵ <https://www.fao.org/wiews/en>

¹⁶ CGRFA-18/21/Report, paragraph 88.

Cooperation and networking

34. All aspects of the management of microbial and invertebrate BCAs and microbial biostimulants would benefit from improved cooperation and networking among stakeholders. The Commission could potentially consider what it can do to promote objectives of this kind. This might include, for example, supporting the establishment of networking platforms that facilitate the identification of expertise for country-level, regional or wider collaborative initiatives, including, in the case of classical biological control programmes, the identification of collaborators in the region of origin of invasive pests. Another option could be stimulating the establishment and operation of research incubators, innovation hubs and working groups covering different aspects of biological control. These could operate at regional or interregional level and could serve as platforms for delivering relevant expertise to developing countries.

Mainstreaming

35. The use and conservation of microbial and invertebrate BCAs and microbial biostimulants are significant to many policy objectives and potentially affected by a range of different policies, including those addressing climate change, sustainable food systems (including agricultural pollution mitigation), One Health, and the conservation (including restoration) and sustainable use of biodiversity in general. As noted above, they are relevant to many of the SDGs. There is a need to raise awareness of these links and to explore opportunities for mainstreaming the management of microbial and invertebrate BCAs and microbial biostimulants into such policies at all levels.

36. The Commission could potentially consider what awareness-raising or facilitating role it might play in terms of ensuring that microbial and invertebrate BCAs and microbial biostimulants are adequately taken into account in policy dialogues and in UN-level working groups, joint commissions or funds.

IV. GUIDANCE SOUGHT

37. The Commission may wish to:

- (i) recommend that FAO hold, subject to the availability of extrabudgetary resources, an open-ended workshop with the aim of: (i) raising awareness of the potential of BCAs and biostimulants; (ii) reviewing the global regulatory situation regarding the import and export of BCAs and biostimulants and access and benefit-sharing arrangements for relevant genetic resources; and (iii) identifying possible regulatory gaps and unnecessary restrictions affecting the use of BCAs and biostimulants;
- (ii) invite countries to promote the sustainable management of BCAs and biostimulants and to take action to promote cooperation and networking among stakeholders in the fields of biological control and the use of biostimulants, for example by supporting the establishment of networking platforms at regional or global levels;
- (iii) recommend that FAO explore the need for the development of information systems related to the use and conservation of microbial and invertebrate BCAs and microbial biostimulants, for example inventories of organisms, impact metrics or relevant policies and report on this to the Commission and other relevant bodies of FAO; and
- (iv) recommend that FAO promote the development of capacity in the management of microbial and invertebrate BCAs and microbial biostimulants.