Declining biodiversity for food and agriculture needs urgent global action

The continuing loss of ecosystems, species and intraspecific genetic diversity has profound implications for agriculture, food security and human wellbeing. An urgent response is needed, including at global level.

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Conserving biodiversity while meeting the needs of human populations for food, fibre, fuel, timber and other products from the world's croplands, grasslands, forests and aquatic ecosystems is a major global challenge. Land- and water-use change, pollution, overharvesting and greenhouse gas emissions associated with food and agriculture are among the most serious threats to biodiversity. At the same time, food and agriculture depend on biodiversity in a multitude of ways. This relates both to species that are directly cultivated and harvested, and to what can be referred to as 'associated biodiversity' — the species and ecosystems that help to create and maintain suitable conditions for production, for example by pollinating crops, maintaining soil fertility, controlling pests or providing habitats for fish.

Global assessment

The Commission on Genetic Resources for Food and Agriculture of the Food and Agriculture Organization of the United Nations (FAO) is the only intergovernmental body specifically charged with addressing policy matters related to the management of all components of biodiversity of relevance to food and agriculture. Over recent decades, the Commission has overseen the preparation of global assessments of crop, livestock, forest and aquatic genetic resources for food and agriculture[1–6]. In the first three cases, the assessments led to the adoption of internationally agreed global plans of action for genetic resources in the respective sector[7–10]. Discussion of a potential policy response to the assessment of aquatic genetic resources, published in 2019, is currently ongoing[11].

In 2007, the Commission decided that its future activities should include a global assessment covering all biodiversity within its mandate, to be published as *The State of the World's Biodiversity for Food and Agriculture* (SoW–BFA)[12]. As the species used directly in crop and livestock production, forestry and aquaculture had been (or were to be) covered in detail in the aforementioned sectoral assessments, the objective was that the SoW–BFA should focus mainly on other categories of biodiversity — particularly associated biodiversity and wild foods — and interactions between categories.

The SoW–BFA process involved inviting countries to prepare reports on the state of their biodiversity for food and agriculture (BFA) based on a set of guidelines agreed by the Commission. The exercise was intended not only as a means of gathering data, but also as a way for countries to identify national priorities related to the management of BFA. Country reporting began in 2013, and 91 reports were submitted. The SoW–BFA[12], which was published in February 2019, also draws on the global scientific literature, reports provided by 27 international organizations and a number of specially commissioned thematic studies.

Box 1 | Biodiversity for the productivity and resilience of food and agricultural systems and livelihoods — examples reported by countries[12]

Kiribati. Integrated farming of milkfish, sandfish sea cucumber and seaweed has proved to be an effective means of securing production and income in fluctuating weather conditions, as one of the components of the system is always producing food.

Zambia. Non-wood forest products, such as caterpillars and wild fruits, have become important commodities in the major towns and cities and serve as an alternative source of household income in periods of drought when farmed crops fail.

India. The country has a rich diversity of native cattle, buffalo, goat, sheep, pig, equine, camel, yak, mithun and poultry breeds. Being adapted to a variety of extreme climatic conditions, as well as to limited resource availability, these breeds greatly contribute to the resilience of livestock production systems. The diversity of livestock and livestock systems also contributes to poverty reduction and food and nutrition security through the supply of nutrient-rich food products and the generation of income and employment.

Ecuador. Traditional local strategies based on biodiversity management are used to reduce the impact of natural or human-made disasters. For example, farmers maintain intraspecific and interspecific crop diversity in plots of land; family and community seed banks assist with the restoration of diversity after crop failures; and crop sowing dates and spatial arrangements are managed to minimize risks.

Sudan. Home gardens are important for food security, nutrition and household income during periods between the harvesting seasons of staple crops. To increase the harvesting period of home gardens, farmers plant a variety of tree and herbaceous species that provide products at different times of the year.

Key findings

For communication purposes, the analysis presented in the SoW–BFA[12] was condensed into the following five key findings.

Biodiversity is essential to food and agriculture. The diversity of biological resources — both domesticated and wild, and at genetic, species and ecosystem levels — contributes to the productivity and resilience of food and agricultural systems, livelihoods and food security in many ways, particularly in the context of climate change. Major benefits include the following:

- The availability of a diverse range of differently adapted species and populations

Fig. 1 | Global state and trends figures for key elements of biodiversity important to food and agriculture. Compilation of data presented in *The State of the World's Biodiversity for Food and Agriculture*[12]. From left to right, top to bottom: crop diversity[3]; crop production species[18,19]; local livestock breeds[20] (calculated on the basis of the data recorded in FAO's Domestic Animal Diversity Information System – DAD-IS); tree species[21]; aquaculture and fisheries species[6,22]; fisheries[23]; pollinators[24]; species contributing to pest and disease regulation[12]; soil biodiversity[25,26]; wild foods[27]; wetlands[28]; mangroves[29]; coral reefs[30–32]; seagrasses[33]; forests[34]; rangelands[35,36] (rangeland area calculated from FAOSTAT land-cover data for 2015 for the following categories: grassland; shrub-covered areas; shrubs and/or herbaceous vegetation, aquatic or regularly flooded; and sparsely natural-vegetated areas). Figure reproduced with permission from ref. [37], FAO.

allows production, and the various ecological processes that support it, to take place in a wide variety of different locations and at different times of year. For example, in dry, wet, cold or hot climates, at different elevations, in different types of soil and in places with different disease or pest challenges.

- Diversity in terms of nutritional content, which varies across different species and within-species populations (varieties, breeds and so on), increases the range of options available for combining foods to provide people with a balanced diet.
- The presence of different types of organisms or biological communities (including those managed for production purposes) can give rise to various kinds of complementarities and synergies. For example, within a field, fish pond or forest stand, combining species with different characteristics (root lengths, feeding habits and so on) tends to allow more efficient use of resources. At farm scale (or among neighbouring farms), combining different types of production creates opportunities to recycle materials that might otherwise be wasted or become pollutants — for instance, use of livestock manure as fertilizer for crops and crop residues as feed for animals. At a larger scale, a forest or grassland, for example, may play a vital role in regulating the supply of water to crop or livestock farms.
- Diversity provides a form of insurance. For example, if a drought or a disease outbreak results in the failure of one crop or the decline of one pollinator population, the presence of others reduces the risk of a devastating impact on production. In many communities, wild foods provide a fall-back option when cultivated crops fail.
- Genetic diversity provides the 'raw material' for adaptation through natural selection, and for breeding programmes aimed at increasing the productivity of domesticated plant or animal populations or enabling such populations to better cope with the challenges posed by their production environments

Specific examples reported by countries from around the world are provided in Box 1.

Multiple interacting drivers of change are affecting BFA. Reporting countries indicated that a wide variety of drivers of change, ranging in scale from global to local and often interacting with each other, are affecting BFA and its management. Changes in land and water use and management featured particularly prominently as negative drivers. Responses related to economic and cultural drivers were mixed (although with negative effects more frequently reported than positive ones). For example, countries reported that demand for uniform products that can be easily processed and retailed is contributing to the homogenization of production systems, but also mentioned cases in which consumer demand for food that is more varied, healthy or responsibly produced is driving the introduction or maintenance of biodiversity-friendly production practices. The only two types of driver for which positive effects were more frequently reported than negative

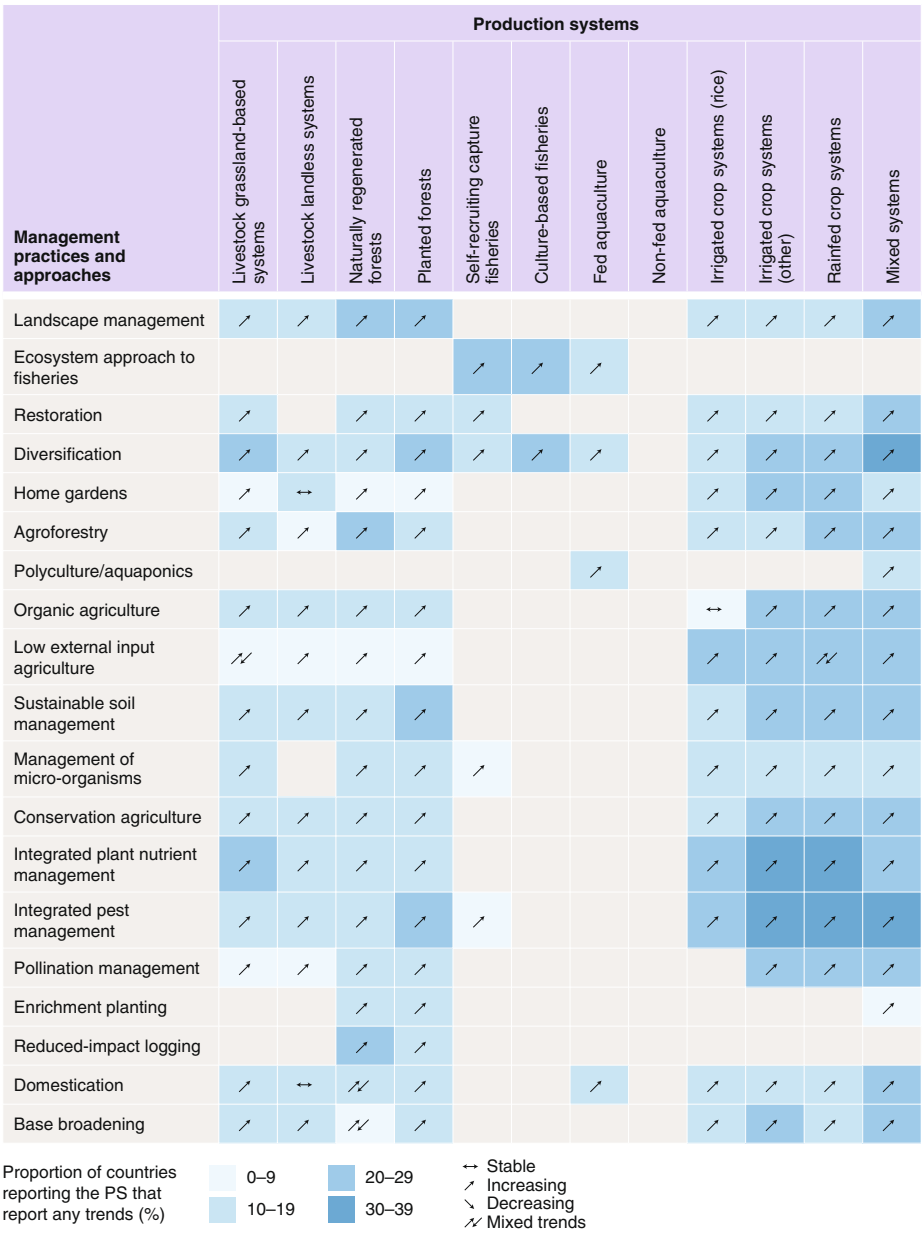

Fig. 2 | Countries' evaluation of trends in the use of selected management practices and approaches. Analysis based on 91 country reports. See ref. [12] for details of the methodology. PS, production systems. Figure reproduced with permission from ref. [12], FAO.

ones were policies (here it should be borne in mind that responses came from national governments) and innovations in science and technology. Both are regarded as potential means of mitigating the effects of other drivers. Where positive policy impacts are concerned, countries generally referred to instruments focused on conservation or environmental protection, particularly in the food and agriculture sector. Reported negative impacts included those caused by policies that promote activities that can lead to significant habitat destruction, such as the construction of roads and dams. The beneficial innovations referred to mostly related to developments that allow producers to reduce the use of environmentally damaging inputs. These can include both 'high-tech' developments and developments based on the use of BFA itself, such as more effective management of soil biodiversity or the natural enemies of pests.

BFA is declining. Information on the status and trends of BFA is patchy, especially in the case of invertebrates and microorganisms. However, the best evidence available indicates that many categories of species and ecosystems that provide vital services to food and agriculture are declining, including pollinators, soil-dwelling organisms, forests, grasslands, coral reefs, mangroves, seagrass beds and wetlands in general (Fig. 1). Many domesticated livestock breeds and crop varieties are at risk of extinction, as are many of the wild relatives of domesticated species.

The use of many biodiversity-friendly practices is reported to be increasing. Countries were invited to report on trends in the implementation of a range of biodiversity-based or potentially biodiversity-friendly management practices. Responses indicating upward trends predominated for almost all combinations of production system and management practice (Fig. 2). Countries generally perceived that these developments were benefiting biodiversity. However, they emphasized the need to improve knowledge of the impacts of different management practices. They also noted the challenges involved in upscaling the implementation of practices identified as biodiversity friendly. While conservation activities, both in situ and ex situ, were generally reported to be becoming more widespread, countries indicated many gaps in coverage. In many cases, conservation programmes reportedly pay little specific attention to ensuring that the supply of ecosystem services to agricultural production systems is maintained. Efforts to improve the management of BFA are often hampered by gaps in knowledge. Countries indicated that even when species are recognized as significant, their characteristics and specific roles in ecosystem function have often received little research attention.

Enabling frameworks for the sustainable use and conservation of BFA remain insufficient. Legal, policy and institutional frameworks for the management of BFA, including those related to research and education, are often weak. Aside from resource constraints, many countries report a lack of effective mechanisms for information sharing and collaboration among stakeholders, particularly between those in the food and agriculture sector and those working on environmental and wildlife issues. There is also recognition that small-scale producers, many of which play vital roles in the management of BFA, are often poorly represented in decision-making processes. Many countries note the importance of developing 'joined-up' strategies that integrate the management of BFA into wider efforts to promote the sustainable management of natural resources and improve livelihoods.

Policy response

The SoW–BFA ends with a call for urgent action to address the decline of BFA and promote its sustainable management. This conclusion is backed up by the findings of several other major recent global studies, notably the *Global Assessment Report on Biodiversity and Ecosystem Services* from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services[13] and the *Special Report on Climate Change and Land*[14] from the Intergovernmental Panel on Climate Change. There is broad consensus about many of the key threats facing biodiversity, and there are numerous examples of success in terms of implementing biodiversity-friendly production methods and strategies. The main missing ingredient in many cases is political will on the part of national governments. However, many practical constraints also need to be addressed.

The Commission's global assessments have led to the adoption of global policy instruments for genetic resources in the crop, livestock and forest sectors[7–10]. While the details vary from sector to sector, these global plans of action share a number of common features. First, the plans condense the outputs of a wide-ranging country-driven global assessment and a process of intergovernmental discussion and negotiation into a set of agreed priorities for action. Although these global priorities need to be translated back into specific priorities at country level, they serve as a guide to national planning efforts, help to raise awareness among policy-makers and provide a framework for monitoring and reporting on implementation. Second, they foster international cooperation and coordination; for example by stimulating the development of international guidelines, standards and protocols for various aspects of management, and by promoting exchange of knowledge and expertise, joint management initiatives and support for capacity building in developing countries.

Although it is impossible to definitively attribute improvements to the influence of the global plans of action, evidence suggests that many aspects of genetic resources management received a boost both in the period immediately following their adoption and — where applicable — over the longer term. For example, many countries report the development of national strategies and action plans for genetic resources within particular sectors of food and agriculture, better integration of genetic resources issues into broader national policies and/or the establishment or strengthening of conservation, breeding or monitoring programmes[15–17].

The SoW–BFA shows that management programmes and collaborative efforts targeting associated biodiversity are underdeveloped relative to those for domesticated crops and livestock, forest trees and species used in aquaculture, both at national level and internationally, and that cross-sectoral collaboration in the management of all components of biodiversity is not well developed either. These findings imply that there is as much need for a coordinated international response for BFA as a whole as there has been for sectoral components. A set of draft global priorities for action on BFA has been developed, and in February 2019 the Commission agreed that this text should be further developed and negotiated "with the motivation to have it adopted as a Global Plan of Action" by the 2021 FAO Conference[11], the highest governing body of FAO.

While action should clearly not be delayed because of ongoing intergovernmental negotiations, a global policy response in this field could help increase the coherence and effectiveness of efforts to protect and better manage BFA. Whatever form such a policy response may take, it will need to be carefully integrated with other international instruments in the field, particularly the existing global plans of action and the Convention on Biological Diversity's forthcoming post-2020 biodiversity agenda, to ensure synergy and complementarity and avoid duplication of work. Even more importantly, it will need to be implemented as a matter of urgency.

The views expressed in this publication are those of the authors and do not necessarily reflect the views of the Food and Agriculture Organization of the United Nations. ❐

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Author contributions

All authors contributed to the conception and design of the paper. D.P. drafted the paper. J.B. and I.H. substantively revised the paper.

Competing interests

All authors are employed by the Food and Agriculture Organization of the United Nations, the work of which is discussed in the paper.