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ASIA REGIONAL SYNTHESIS FOR

THE STATE OF THE WORLD'S BIODIVERSITY FOR FOOD AND AGRICULTURE

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Foreword

We have known for some time that human activity is eroding biodiversity – the amazing variety of life at genetic, species and ecosystem levels. We know that forests are being lost to agriculture, that many fish stocks are overfished and that species, breeds and varieties are sometimes lost even before we can record them. The report on *The State of the World's Biodiversity for Food and Agriculture*, published by FAO earlier this year, provides an in-depth account of this decline.

This synthesis report for Asia, prepared as a contribution to the global report, explores in detail the information provided by eight countries on the state and trends of the species, breeds, varieties and strains of wild and domesticated terrestrial and aquatic plants, animals and micro-organisms that contribute to food production and agriculture.

It also looks at the multiple challenges countries face, individually and as a region, in sustainably managing and better safeguarding these resources, and describes countermeasures and innovative solutions. Countries in the region are adopting biodiversity-friendly practices in the crop, livestock, forest, fisheries and aquaculture sectors, with the implementation of ecosystem approaches to fisheries and aquaculture, restoration, diversification, home gardening, agroforestry, organic agriculture, integrated pest management and various approaches to sustainable pasture management all widely reported.

This is good news in terms of two of FAO's regional priorities – enhancing equitable, productive and sustainable natural resource management and utilization and strengthening food and nutritional security. However, the declining state of biodiversity and the high level of hunger in the region are compelling evidence that much more action is needed. With 74 percent of the estimated 570 million farms, 85 percent of the world's fishers and fish farmers and over 60 percent of the world's undernourished people located in Asia, decisions taken in the region will affect the livelihoods and food security of a large portion of the world's population.

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About this report

BACKGROUND

This report summarizes the state of biodiversity for food and agriculture (BFA) in Asia based on the information provided in country reports submitted to FAO as part of the reporting process for the report on *The State of the World's Biodiversity for Food and Agriculture*. A first draft, based on six country reports, was prepared as supporting documentation for an informal regional consultation on the state of Asia's BFA held in Bangkok, Thailand, 26 to 28 April 2016. The document was later revised based on feedback received from the participants of the informal consultation, additional country reports (two) and country-report updates received by FAO before September 2016. During the informal consultation, participants also discussed regional needs, priorities and possible actions for the conservation and sustainable use of BFA.[1]

SCOPE

The report addresses the BFA (see working definition below) found in plant, animal, aquatic and forest production systems and the ecosystem services associated with them. It focuses particularly on associated biodiversity (see working definition below) and on species that are sources of wild foods.

WORKING DEFINITIONS

The working definitions of biodiversity for food and agriculture and associated biodiversity used for the purposes of this report (and in the country-reporting process for *The State of the World's Biodiversity for Food and Agriculture*) are described, along with other key concepts, in FAO (2019).

Biodiversity for food and agriculture

BFA includes the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the ecosystem structures, functions and processes in and around production systems, and that provide food and non-food agricultural products and services. Production systems, as defined for the purposes of this report, include the livestock, crop, fisheries and aquaculture and forest sectors. The diversity found in and around production systems has been managed or influenced by farmers, pastoralists, forest dwellers and fisherfolk over many hundreds of generations and reflects the diversity of both human activities and natural processes. BFA also encompasses the wild foods of plant, animal and other origin.

Associated biodiversity

Associated biodiversity comprises those species of importance to ecosystem function, for example through pollination, control of plant, animal and aquatic pests, soil formation and health, water provision and quality, etc., including *inter alia*:

a) micro-organisms (including bacteria, viruses and protists) and fungi in and around production systems of importance to use and production such as mycorrhizal fungi, soil microbes, planktonic microbes, and rumen microbes;
b) invertebrates, including insects, spiders, worms, and all other invertebrates that are of importance to crop, animal, fish and forest production in different ways, including as decomposers, pests, pollinators, and predators, in and around production systems;s;
c) vertebrates, including amphibians, reptiles and wild (non-domesticated) birds and mammals, including wild relatives, of importance to crop, animal, fish and forest production as pests, predators, pollinators or in other ways, in and around production systems;

[1] See Annex 2 of *Report of the Informal Regional Consultation on the State of Asia's Biodiversity for Food and Agriculture* (CGRFA-16/17/Inf.11.2) (FAO, 2016).

d) wild and cultivated terrestrial and aquatic plants other than crops and crop wild relatives, in and around production areas such as hedge plants, weeds, and species present in riparian corridors, rivers, lakes and coastal marine waters that contribute indirectly to production.

Domesticated species may also provide ecosystem services other than provisioning ones and affect crop, animal, fish and forest production in different ways.

Executive summary

WHAT IS BIODIVERSITY FOR FOOD AND AGRICULTURE?

"Biodiversity is the variety of life at genetic, species and ecosystem levels. Biodiversity for food and agriculture (BFA) is, in turn, the subset of biodiversity that contributes in one way or another to agriculture and food production. It includes the domesticated plants and animals raised in crop, livestock, forest and aquaculture systems, harvested forest and aquatic species, the wild relatives of domesticated species, other wild species harvested for food and other products, and what is known as 'associated biodiversity', the vast range of organisms that live in and around food and agricultural production systems, sustaining them and contributing to their output [such as natural enemies of pests, pollinators, soil micro-organisms]. Agriculture is taken here to include crop and livestock production, forestry, fisheries and aquaculture" (FAO, 2019).

ABOUT THIS REPORT

This report summarizes the state of biodiversity for food and agriculture in Asia based on the information provided in country reports submitted to FAO as part of the reporting process for *The State of the World's Biodiversity for Food and Agriculture*. The document was prepared as supporting documentation for an informal regional consultation on the state of Asia's biodiversity for food and agriculture held in Bangkok, Thailand, 26 to 28 April 2016.

SUMMARY

As of September 2016, 8 out of 24 countries from the Asia region had officially submitted a country report to contribute to the preparation of *The State of the World's Biodiversity for Food and Agriculture*. This regional synthesis report provides a synthesis of their inputs, organized into four main areas: (i) assessment and monitoring; (ii) conservation and sustainable use; (iii) policies, institutions and capacity; and (iv) regional and international cooperation.

Asia, the world's largest and most populated continent, is characterized by many different forms of diversity. It has various religions, cultures and traditions, encompasses a wide range of climatic and topographic conditions, and is also one of the world's most biodiverse regions, including in terms of biodiversity for food and agriculture (BFA). For centuries, farmers, livestock keepers, fishers and forest dwellers have maintained and used a broad range of species in and around production systems, shaping the region's landscapes, seascapes and ecosystems. Over the past decades, however, Asia's wealth of BFA has been declining. Changes in land and water use and management have been one of the main factors leading to this decline. To intensify production, large areas forest and wetland have been converted into arable land farmed under monoculture systems. The use of pesticides, herbicides and mineral fertilizers has been drastically increased. These changes have led, *inter alia*, to widespread soil and water pollution and concentration on an ever-smaller number of economically profitable, higher-yielding species, varieties and breeds. Other factors that have taken their toll on BFA include overexploitation and overharvesting, climate change and the proliferation of invasive alien species. Natural and human-made disasters also have adverse impacts on BFA.

Awareness of the causes and consequences of biodiversity loss in the region is increasing and several countries are undertaking efforts to reverse declining trends, for example by establishing protected areas to maintain forests and other ecosystems.

As is the case of other regions, Asia's associated biodiversity is monitored less systematically than its animal (livestock), plant (crop), forest and aquatic (fisheries and aquaculture) genetic resources. Data on associated biodiversity are often gathered through one-off surveys or in the context of short-term projects and therefore provide no more than snapshots of the status of given components of biodiversity. Despite the lack of precise data, all the reporting countries indicate

that the status of associated biodiversity is deteriorating. They also generally agree that there is a need to collect baseline data on associated biodiversity and to establish systematic monitoring programmes.

Where wild food resources are concerned, despite the lack of recorded and published details, countries indicate that their availability and diversity, as well as knowledge of their characteristics and possible uses, have been declining. This is a matter of concern given that numerous communities across the region rely heavily on wild food resources for their food intake, particularly during periods of food scarcity. Countries expressed the need for an inventory of wild food species, including of their characteristics and possible untapped values, and for the development of plans and strategies to ensure the conservation and sustainable use of these resources.

Management strategies and practices that are considered to support the maintenance and use of BFA seem to be more frequently applied in crop and forest systems than in aquatic, livestock and mixed production systems. Integrated pest management, integrated plant nutrient management and water management were among the most frequently reported practices in crop production systems. In the case of forest production systems, agroforestry, integrated plant nutrient management and restoration practices were among the most commonly reported. The importance of diversification was highlighted both for capture fisheries and for fed-aquaculture systems. Overall, more research is needed on the effectiveness of diversity-based and other potentially biodiversity-friendly management practices in terms of the maintenance and use of BFA. Findings in this field also need to be made available to the relevant stakeholders, ranging from farmers to policy-makers.

In Asia, BFA is widely used to cope with natural or human-made disasters. For example, saline-tolerant varieties of rice are supplied to farmers following cyclones to help them cope with soil salinization. Diversification and crop-cycle management strategies have been put in place to ensure food availability during floods. The importance of the availability and use of wild foods during severe food shortages, some of which are caused by natural disasters, is also emphasized in the country reports. Crop and livestock diversity, in particular the diversity of locally adapted plant and animal genetic resources, including underutilized and neglected crops and crop wild relatives, is considered of key importance for adaptation to climate change, including through genetic improvement. The country reports also describe a few cases in which components of BFA have been used to slow the spread of invasive alien species in aquatic and terrestrial ecosystems. However, in none of these cases have the negative impacts of the invasive species been kept fully under control.

Fewer than half of the reporting countries indicated that they had adopted landscape, seascape or ecosystem approaches, including the ecosystem approach applied to fisheries. Several countries reported that they considered the development and application of such approaches to be a priority, in particular in agricultural production systems. They expressed the need for guidelines and action plans to assist them in the development of relevant policies and strategies.

In Asia, traditional knowledge plays an important role in the use of BFA. Indigenous communities in particular hold and maintain unique knowledge about the uses of local species, varieties and breeds. Some countries noted the crucial role of women, whose decision-making power in agricultural production greatly influences the use and conservation of BFA.

The conservation of many components of BFA remains challenging. The absence of adequate data, along with a lack of financial and human resources, poses severe constraints to the reinforcement of existing conservation initiatives and the development of new strategies.

Protected areas seem to be the most common form of conservation of associated biodiversity and wild food species in the region. For the conservation of aquatic resources and ecosystems in particular, several countries highlighted the importance of marine protected areas and national parks containing lakes, rivers and wetlands. Despite hindrances and setbacks, varying from illegal exploitation to political instability and social unrest, the region's total area covered by protected areas continues to expand.

The country reports include a number of examples of initiatives specifically targeting the *ex situ* conservation of associated biodiversity and wild food species, including microbial culture

collections maintaining taxonomically diverse groups of micro-organisms for utilization in the agriculture, horticulture, pharmaceutical, cosmetic, agrifood or other industries, conservation of biological control agents under ambient laboratory conditions and cryopreservation of milt from various fish species.

Countries generally agree that an integrated approach involving *in situ* and *ex situ* conservation strategies is the best way to conserve biodiversity for food and agriculture. *In situ* conservation enables species to evolve by allowing natural selection to act. *Ex situ* conservation can be a safety net for threatened species that may, for example, need to be reintroduced and/or be included in restoration programmes following natural or human-made disasters.

The need to regulate access to components of BFA and facilitate the fair and equitable sharing of benefits derived from their use is recognized across the region. Most of the reporting countries have revised, are in the process of revising or are developing new laws and policies in this field, including provisions related to access to and the utilization of resources belonging to indigenous and local communities and their associated knowledge. With respect to the implementation of the Nagoya Protocol in particular, most countries reported that they needed additional guidance at institutional level on the development of appropriate national legislation.

Countries in Asia have put in place a range of national policies, laws and programmes for the conservation and sustainable use of BFA. While some of these regulatory frameworks focus on animal, plant, forest and/or aquatic genetic resources (e.g. national livestock development policies or seed acts), others aim to conserve and promote the sustainable use of entire ecosystems and the species they contain (e.g. coastal zone and wetland policies or soil and water conservation acts). With respect to the conservation and, to a far lesser extent, use of associated biodiversity and wild food species, many country reports note the importance of national biodiversity and action plans. National disaster management plans and climate change adaptation and mitigation policies and programmes were also reported to be highly relevant to the conservation and sustainable use of BFA.

Overall, cooperation between different ministries in the management of BFA seems to be limited to non-existent, even where national policies and programmes of relevance to more than one sector are in place. This lack of cross-sectoral collaboration is considered to be a serious impediment to the successful implementation of such policies and programmes.

Across the region, many higher education institutions offer courses related to the conservation and sustainable use of BFA, including associated biodiversity. As in other regions, however, in most education and research programmes, issues related to conservation of biodiversity are usually addressed separately from those related to sustainable use. As a result of this "decoupling", trained experts tend to lack skills in interdisciplinary work. Overall, education programmes do not adequately cover cross-cutting issues of relevance to BFA, such as climate change, nutrition and access and benefit-sharing. Some countries consider training and capacity building of farmers in the sustainable management of BFA and to be a priority.

Strengthening knowledge on associated biodiversity and ecosystem functioning is considered a priority by most countries. Advancing research in these fields requires effective prioritization of the species or groups of species to be targeted, a continuous flow of sufficient funding and adequate human resources. To improve the conservation and sustainable use of BFA, knowledge also needs to be strengthened on the contribution of wild food species to food security and livelihoods, the application and effect of sustainable management practices, the adoption and implementation of ecosystem approaches and the introduction and ecological and economic impacts of invasive alien species.

Regional collaboration in the field of BFA could be strengthened, particularly with respect to work on micro-organisms, invertebrates, invasive alien species, the application of sustainable management practices, the adoption and implementation of ecosystem approaches and the use BFA in coping with climate change, invasive alien species and natural or human-made disasters.

I. Assessment and monitoring of biodiversity for food and agriculture

1.1 REGIONAL CONTEXT

Afghanistan, Bangladesh, Bhutan, China, India, Nepal, Sri Lanka and Viet Nam are the eight Asian countries from a total of 24[1] to have submitted a national report as a contribution to the preparation of *The State of the World's Biodiversity for Food and Agriculture*.[2] These countries combined cover an area of approximately 14 270 740 km², including land and water, which is about 67 percent of the region's total territory (Table 1). Even if contributions from megadiverse countries such as Indonesia and the Philippines are missing, the countries that submitted a national report are close to providing a representative sample of the region's ecosystems, production systems and biodiversity hotspots.

Table 1. Percentage of land, water, agricultural and forest areas in Asia located in countries that provided country reports

	Total area	Land area	Water area[1]	Agricultural area	Forest area
% covered by country reports	67	66	22	73	55

[1] Percentage of Exclusive Economic Zones.
Source: Calculated from FAOSTAT data for 2014.

Biodiversity hotspots in Asia

The Critical Ecosystem Partnership Fund identified eight biodiversity hotspots in Asia, located in the Himalaya, Indo-Burma, Japan, the Mountains of Southwest China, the Philippines, Sundaland, Wallacea and the Western Ghats, and Sri Lanka.[3] These hotspots are spread over large parts of Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, the Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka, Thailand, Timor-Leste and Viet Nam. They are known for their wide variety of climates and ecosystems and are home to an unusually high number of endemic bird, mammal, reptile, amphibian and vascular plant species. For example, in the Himalaya, ecosystems range from alluvial grasslands and subtropical broadleaf forests to alpine meadows above the tree line; Indo-Burma holds remarkable endemism in bird and freshwater-turtle species; the Mountains of Southwest China include the most endemic-rich temperate flora in the world; and the Western Ghats and Sri Lanka are rich in an endemic assemblage of plants, reptiles and amphibians.

The primary threats to biodiversity in Asia's hotspots include the clearing of forests (e.g. for farming or other economic activities or to accommodate growing human populations), increasing demand for timber and fuelwood, illegal hunting, overgrazing and infrastructure development.

Five of the world's 17 most megadiverse countries[4] are in Asia: China, Indonesia, India, Malaysia and the Philippines. In terms of species richness in vascular plants, China ranks third in the world after Brazil and Colombia with 35 000 species, more than half of which are endemic.[5] The country is also rich in wetlands and hosts more than 20 000 marine species (more than 10 percent of the

[1] Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Timor-Leste, Viet Nam.

[2] The following webpages give an overview of FAO Member countries grouped according to their regional distribution: Africa: http://www.fao.org/africa/countries/en/; Asia and the Pacific: http://www.fao.org/asiapacific/countries/en/; Europe and Central Asia: http://www.fao.org/europe/countries/en/; Near East and North Africa: http://www.fao.org/neareast/countries/en/; Latin America and the Caribbean: http://www.fao.org/americas/paises/en/; North America: http://www.fao.org/north-america/fao-in-north-america/about-us/en/

[3] See Critical Ecosystem Partnership Fund (CEPF) at: http://www.cepf.net/resources/hotspots/Asia-Pacific/Pages/default.aspx

[4] The 17 megadiverse countries are a group of nations that together are home to more than 70 percent of the Earth's biodiversity, while covering a territory of only 10 percent of the Earth's surface.

[5] https://www.cbd.int/countries/profile/default.shtml?country=cn

Table 2. Production systems reported in Asia

Production system	Countries reporting
Livestock grassland-based	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Livestock landless	Bangladesh, China, India, Nepal, Sri Lanka, Viet Nam
Naturally regenerated forests	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Planted forests	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Self-recruiting capture fisheries	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Culture-based fisheries	Bangladesh, China, India, Nepal, Sri Lanka, Viet Nam
Fed aquaculture	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Non-fed aquaculture	Bangladesh, China, India, Nepal, Sri Lanka, Viet Nam
Irrigated crops (rice)	Bangladesh, Bhutan, China, Nepal, Sri Lanka, Viet Nam
Irrigated crops (non-rice)	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Rainfed crops	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Mixed systems	Bangladesh, Bhutan, China, India, Nepal, Sri Lanka, Viet Nam
Other production systems	
Vegetables in floating beds	Bangladesh
Fish polyculture systems of fish (semi- intensive)	Sri Lanka
Monoculture of shrimp (intensive & semi intensive)	Sri Lanka
Poultry and dairy industrial production systems	India
Production systems in national parks	Viet Nam

Note: For a description of the production-system classification used in the reporting process, see Table 1.1 in FAO (2019).
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

world's total). Harbouring nearly 8 percent of the total number of recorded species of the world, India also stands out as a highly biodiverse country.[6] China and India are also two of the world's eight Vavilovian centres of origin and diversity of crop plants.

Main production systems in the region

The country-reporting guidelines provided by the Food and Agriculture Organization for the United Nations (FAO) invited countries to list their production systems in accordance with the categories shown in Table 2. Some constraints were encountered in this regard; for example:

1. countries interpreted the various production system categories differently; and
2. countries faced difficulties in providing information according to the proposed classification (e.g. the areas covered by each production system).

Because of these constraints, no decisive conclusions can be drawn at the production-system level based on the information provided in country reports.

1.2 STATUS, TRENDS AND DRIVERS OF CHANGE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

1.2.1 Main drivers of change affecting genetic resources for food and agriculture

Asia is one of the richest regions in the world in terms of BFA. Its broad array of agroecological zones supports a wide range of animal, forest, plant and aquatic genetic resources, which are typically grown or kept by smallholders, very often in mixed production systems (e.g. mixed crop–livestock farming, integrated rice–prawn farming and agroforestry systems). For centuries, the rich species diversity found in and around the region's production systems has been maintained

[6] https://www.cbd.int/countries/profile/default.shtml?country=in

Box 1. Floating gardens in Bangladesh, a traditional production system for growing vegetables in water-logged and salinity-prone areas

In the wetlands of the south-central coastal districts of Bangladesh, farmers have developed the unique floating garden production system (locally known as Dhap). A wide range of vegetables and other crops are grown, almost all year round, on beds made of water hyacinths and other aquatic plants such as *tapapana*, *dulalilata* and *khudipana* that are widely available locally. In summer, okra, ribbed gourd, Indian spinach, brinjal, cucumber, red amaranths, stem amaranths and wax gourd are the most commonly grown vegetable crops, while turnip, cabbage, cauliflower, tomato and red amaranths are grown in winter. Spices grown include turmeric and chilli. Mixed intercropping is the predominant form of production in floating gardens and pest and disease infestations are minimal. As decomposed water hyacinths are used as fertilizer, external-input requirements and production costs are low. Under flood conditions, the open water is used for fishing. In this region of Bangladesh, floating gardens are the only food-production and livelihood option for 60 to 90 percent of the local communities.

Options for further improving the floating-garden production system include strengthening the social organization and distribution of activities at the local level, improving product marketing and developing scientifically recommended, adapted crop-production packages and ad hoc agroprocessing activities.

Source: Adapted from the country report of Bangladesh.

and used by farmers, livestock keepers, fishers and forest dwellers. Typically, the diversity within these species is also high, which contributes, *inter alia*, to the species' potential to adapt to environmental changes.

The report from Bangladesh refers to the country's immense diversity in rice (approximately 8 000 landraces), jute, millet, legume, pulse, oilseed, taro, yam, sweet potato, litchi, melon, citrus, mango, jackfruit, jamun, guava, banana, plantain, areca nut, coconut and jujube varieties. Sri Lanka identifies more than 400 species of wild relatives of rice and other crops in farmlands, forests and wetlands. Nepal refers particularly to its large diversity of underutilized crop species. The country hosts more than 500 edible plant species, only about 200 of which are cultivated. China reports that it has more than 50 varieties of rice, wheat and beans, more than 30 varieties of maize, millet, sweet potato and peanut, 18 varieties of cotton and more than 600 tea varieties. In terms of fruit trees, China reports 1 015 varieties of mulberry tree and about 300 varieties of other fruit-tree species, including of apple, pear, citrus, peach, apricot, plum, litchi, longan, chestnut, walnut and date (palm) trees. It also has a range of different strawberry, pineapple and grape varieties.

The region is also characterized by a rich diversity of livestock species and breeds and of aquatic genetic resources. For example, Viet Nam reports that it has more than 45 local livestock breeds, including 14 pig and 16 poultry breeds. India reports 13 mammalian and avian livestock species, within which there are numerous breeds (the country has officially registered 42 sheep, 40 cattle, 26 goat, 17 chicken ,13 buffalo, 9 camel, and 6 pig breeds). It also hosts a wide array of fish species, including 3 398 finfish (1 887 marine, 936 freshwater, 113 brackish-water and 462 exotic fish species). China reports that it has about 600 domesticated breeds of animals, including ass, cattle, horse, sheep, pig, chicken, duck, goose, pigeon, rabbit, dog, silkworm, bee and goldfish breeds. China also mentions its rich aquatic biodiversity, which includes more than 800 freshwater fish species and 2 156 marine fish species. Nepal likewise refer to its rich freshwater biodiversity, which includes the more than 230 fish species present in the country's three major river systems, along with an array of other aquatic animals and plants.

China harbours more than 8 000 species of woody plants, including about 2 000 tree species. The country is also rich in endemic tree species, belonging to, *inter alia*, the Ginkgoaceae, Rhoipteleaceae, Sargentodoxaceae, Laniidae, Eucommiaceae, Tapisciaceae and Nyssaceae families. About 1 000 tree species are considered to be of important economic value, among which more

than 300 species are grown in plantations. Nepal also stands out for the diversity of the forest-tree species present in the country's 118 recognized forest ecosystems and 35 forest types, ranging from tropical forests to alpine shrub (Paudel, Bhattarai and Kindlmann, 2012).

The reporting countries seem to agree that the region's wealth of BFA has been declining over recent decades. Changes in land and water use and management, including those caused by production intensification, were identified as the main drivers negatively affecting biodiversity in and around production systems. The introduction of monocultures, increasing mechanization (even if still moderate in some countries), pollution caused by the use of external inputs such as fertilizers and pesticides, overexploitation and overharvesting have taken a particular toll on BFA and related ecosystems. China is among the reporting countries that refers to pollution as one of the main drivers of biodiversity loss. It notes that it accounts for 40 percent of the world's total consumption of synthetic fertilizers and uses 2.5 times more pesticides per unit area than the world average.

Plant genetic resources

With regard to plant genetic resources, all reporting countries consider the introduction of high performing, mostly hybrid, varieties to be a major threat to local crop diversity. India mentions having subsidy programmes in place to encourage farmers to grow high-yielding crop varieties. While recognizing that the use and dissemination of new improved rice varieties enabled the country to become self-sufficient in rice production, Sri Lanka points out that low-yielding traditional rice varieties taste better, are more nutritious and are more resilient to pests and diseases. Bangladesh reports that many local vegetable varieties, while still available in genebanks, are no longer cultivated.

More than 80 percent of Viet Nam's native crop varieties are also reported to have been lost through various forms of modernization. This loss is particularly pronounced among the country's rice, tea, fibre crop and fruit varieties. In China, the simplification of agriculture as a result of the country's "one village, one product" policy, is reported to have contributed to the spread of high-yielding crop varieties at the expense of local ones. As the result of, *inter alia*, the use of chemical fertilizers and the vigorous promotion of hybrid rice varieties, the Take Hani community on the south bank of the Red River, for example, lost its knowledge of rice seed selection and cultivation, and its festival custom connected to terraced rice cultivation also disappeared.

Animal genetic resources

Many different livestock species are raised in the region, including cattle, buffalo, sheep, goats, chickens, ducks and pigs. Livestock farming is predominantly small scale and based on the use of indigenous livestock breeds. Over recent decades, largely driven by population growth, the rapidly increasing demand for livestock products has led to the introduction of numerous high-producing exotic breeds across the region. The spread of such breeds has led to a decline in native livestock populations and to the loss of several indigenous breeds.

Viet Nam reports that the populations of some of its animal breeds are believed to be declining at a rate of about 10 percent per year. India reports that its indigenous livestock breeds are under serious threat from the introduction of exotic breeds. In the case of cattle, for example, indigenous breeds are often replaced by exotic, high-producing dairy cattle breeds or their crosses. Nepal, a country that is also known to be rich in animal genetic resources, both in terms of diversity and population sizes, reports that its yak populations are experiencing drastic declines. These declines are attributed to cross-breeding with cattle, but also to herders abandoning yak rearing, for example to move into activities such as tourism. China reports that its single-product development approach, along with cross-breeding between local and exotic breeds, has contributed to the decline of its mammalian and avian livestock breeds. At the same time, however, it indicates that the rapid development of industrial livestock farming, large-scale breeding and the application of innovative breeding techniques have greatly enhanced production performance.

Forest genetic resources

Most of the country reports indicate that forest tree species diversity is under threat from, *inter alia*, changes in land and water use and management, pollution, overexploitation, market dynamics, pests and diseases and climate change. At the same time, however, they note that recent sociopolitical changes appear to be having a positive effect the status of tree species diversity. For example, Nepal mentions that it has established four kinds of protected areas (national parks, wildlife reserves, conservation areas and buffer zones) to protect its forest ecosystems and forest types. Bangladesh reports that its forest cover is expanding, although this is mainly as a result of an increase in forest plantations that have lower species diversity than natural forests. Trees have been planted along roads and railroads and mangroves have been planted along the southern coastal frontier. The area covered by biodiversity-rich natural forests is however declining and increasingly fragmented. Over the past two decades, vast forest areas have disappeared because of their conversion to aquaculture and agriculture. China also reports that the loss of its forest genetic resources accelerated over the past decade. Many tree species in the country are estimated to be critically endangered or at the verge of extinction, mainly as a result of overexploitation and the simplification of afforestation approaches (i.e. the promotion of large-scale, single species plantations). Viet Nam reports that two-thirds of its natural forests are in poor condition or regenerating. It refers to a serious decline in valuable tree species used for timber, construction and furniture and notes that forest loss and degradation have caused desertification and land impoverishment, which have led to more floods and droughts. Sri Lanka reports that the natural intraspecific genetic diversity of forest tree species used in forest regeneration is narrow and that only a limited number of indigenous tree species are used in this context.

Aquatic genetic resources

Overall, the number of freshwater and marine fish species at risk of being lost in the region seems to have significantly increased over recent decades. This trend is reported to be driven by numerous factors, including overfishing, increased poaching, irresponsible use of freshwater and marine ecosystems, pollution (eutrophication), climate change (e.g. rising temperatures are leading to erratic rainfall and increased flooding, as well as to the melting of snow in the Himalaya), natural disasters in the form of floods, landslides, river blockages and avalanches, draining of wetlands, poor law enforcement and political unrest. India reports that in 2015 its total fish production fell by 5.3 percent due to climate change and the effects of El Niño. The main fish species affected were sardine, mackerel and other small pelagic fish. It also mentions that the number of fishing craft operating and the types of fishing gear employed are leading to overharvesting. China indicates that climate change, along with pollution caused by industrial, urban and agricultural wastes, has severely affected the country's aquatic ecosystems over the past ten years, including the species composition of their fish populations. Viet Nam reports similar trends, but identified overexploitation as the main driver of change behind the decline of both freshwater and marine fish populations, including of fish species of economic importance. Bangladesh reports that it is very rich in indigenous fish species. Its water bodies harbour 267 freshwater, 475 marine and 24 exotic fish species, as well as a number of other vertebrate and invertebrate species. However, the country's aquatic biodiversity seems to be rapidly declining. More than 100 of its riverine fish species are in danger of extinction, with a number of species having already disappeared, including a significant number of smaller indigenous fish species that were once consumed by poor people in rural areas. Bangladesh also reports that the production share of inland capture fisheries is declining, largely to the benefit of aquaculture.

The country reports indicate that invasive alien species are having a significant impact on aquatic biodiversity. Water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) are, for example, reported to be particularly destructive of aquatic biodiversity in Nepal. The spread of African catfish (*Clarias gariepinus*) is also negatively affecting the ecological balance in the country's warm-water wetlands and ponds.

1.2.2 Status, trends and drivers of change of associated biodiversity, ecosystem services and wild food resources

Correlation between genetic resources for food and agriculture, associated biodiversity and ecosystem services

Knowledge of the relationships between genetic diversity in agriculture, forestry and fisheries, associated species and ecosystem functioning is still relatively limited in the region. Sri Lanka reports that in some cases increased crop diversity is known to promote the diversity of associated organisms. It also mentions a positive correlation between forest-tree species diversity and the occurrence of both associated biodiversity and wild food species. Nepal mentions that it lacks data on whether the diversity of plant, animal, forest and aquatic genetic resources positively influences ecosystem functioning.

Invertebrates

Nepal reports that, while it has no any specific monitoring system for associated biodiversity, declines of local honey-bee species, such as *Apis laboriosa* and *A. florea*, have been observed and that the main causes of these declines are honey harvesting, habitat destruction and the indiscriminate use of pesticides. Viet Nam reports that pollution is one of the main threats to the survival of the natural enemies of insect pests. Similarly, Sri Lanka notes that high levels of use of chemical inputs, as well as mechanical disturbance of soils, are among the main factors leading to the erosion of biodiversity and the degradation of ecosystem functioning (e.g. soil formation and protection, water purification and waste treatment) in agricultural and aquatic production systems.

Micro-organisms

India mentions its concern over the effects of environmental degradation on the country's microbial species richness and abundance. It emphasizes the importance of conserving and studying this microbial diversity.

Associated biodiversity in aquatic ecosystems

Several countries report that water-management practices, such as the construction of dams and reservoirs, as well as hydroelectric power schemes, have led to the fragmentation of rivers, which has in turn led to the loss aquatic biodiversity and the degradation of river ecosystems. Countries also mention that hydropower constructions block the migration routes of commercially valuable fish species, disturb the spawning grounds and habitats of various aquatic species, contribute to the loss of forest-tree species in valleys and on riverbanks, and negatively affect downstream habitats, including estuaries and coastal ecosystems.

Most countries report rapid industrialization and urbanization among the main factors causing eutrophication of rivers and lakes. The increasing amount of waste and sewage containing high levels of nitrogen and phosphorus is causing biodiversity loss and the degradation of aquatic ecosystems. Viet Nam notes that intensive aquaculture, in particular catfish farming in the Mekong Delta, significantly contributes to eutrophication in fish-farming areas. The country's fisheries-harvest policies are reported to have led to overexploitation and poaching of fish in marine ecosystems. They have also contributed to the degradation of natural habitats, such as intertidal zones, coral reefs and seagrass beds. Bangladesh also refers to overexploitation as a major threat to a number of wild-food resources, including marine species such as crabs and oysters.

Associated biodiversity in forest ecosystems

In Viet Nam, overexploitation is reported to negatively affect the status of wild plant species associated with forests, including of those that are used for construction, medicinal, cosmetic and ornamental purposes. While Viet Nam also refers to the continuous degradation of its mangrove

forests,[7] it reports that downwards trends in mangrove area have levelled off as a result of planting. The planted mangrove forests are, however, less diverse than the wild ones.

Ecosystem services in production systems

Nepal reports that agroforestry positively contributes to the maintenance of ecosystem services that are essential to sustainable agriculture, such as soil formation. India indicates that increased use of cross-bred animals has made the prevention and control of livestock diseases more difficult. It notes, in particular, higher incidence of infectious bovine rhinotracheitis and mastitis in cattle, foot rot in sheep, swine fever in pigs and bird flu in poultry.

Wild food species

All the reporting countries indicate that wild food species are of key importance to livelihoods and food security. Some tribal communities in Nepal are reported to depend heavily on wild food resources for their food intake, particularly during periods of food scarcity. One tribe in particular, the Chepang, is believed to have lived solely from hunting and gathering for the past 150 years. Nepal also mentions the importance of forest-associated wild food species, including wild edible plants, to food security, poverty alleviation and sustainable development. Wild edible plants provide staple food and essential nutrients to indigenous peoples and local communities, reducing their vulnerability to food insecurity and providing a buffer in times of food shortage. They can also serve as complementary food and as an alternative source of cash income. In addition, they can be used for the development of new crop varieties through domestication or hybridization.

Bangladesh mentions that mountain communities largely depend on meat derived from wild animals, such as wild boar (*Sus scrofa scrofa*), red jungle fowl (*Gallus domesticus murgi*) and wild quail (*Cotamix coromandelica*), for their protein intake. It also reports that a number of wild animals such as the swamp dear (*Cervus duvaucelii*), the one-horned rhinoceros (*Rhinoceros unicornis*) and the wild water buffalo (*Bubalus arnee*) that were once abundant and used as food have become extinct in the country.

China indicates that, in recent years, with improving living standards and increasing health consciousness among consumers, local governments and enterprises have shown increased interest in the maintenance, improvement and utilization of wild plants as some are believed to have a higher nutrient content than some cultivated ones.

Countries report that in recent decades there has been a decline (to varying degrees across the region) in the availability and diversity of certain wild food species and that knowledge of such species has also been negatively affected. While only few of Nepal's wild edible plant (WEP) species have been documented, particularly in the case of medicinal plants, the status of WEPs is believed to have deteriorated as a result of (the often cumulative) effects of land-use changes (e.g. expansion of agricultural lands and infrastructure development, habitat destruction as a result of timber harvesting, fuelwood collection, forest fires, overharvesting, overgrazing and invasive species). Increasing reliance on processed foods is also reported to have led to a significant loss of knowledge related to the diversity, use and status of WEPs. In view of their vital and multiple roles, Nepal considers the evaluation and documentation of traditional knowledge about WEPs to be a priority. It also mentions that land-use changes such as infrastructure development have increased access to wild foods in remote areas.

India notes that its fungi diversity is rapidly depleting as a result of deforestation, urbanization and climate change, with some species, particularly mycorrhizal mushrooms, reported to be on the brink of extinction. Wild tubers, fruit and nut trees and fish species are reported to be threatened by overharvesting, and the latter also by habitat loss and alteration.

[7] Viet Nam lost 270 000 of its 400 000 hectares of mangrove forests between 1943 and 2012.

Box 2. Effects of invasive alien species on biodiversity for food and agriculture

India reports that many invasive terrestrial and aquatic plant species that have entered the country accidentally are causing serious economic and environmental damage in forest areas, tea, rubber and other crop plantations, grazing areas and water bodies. These species are reported to be difficult to keep under control. In China, the rapid development of international trade has meant that the number of invasive alien species (IAS) in the country has steadily increased in recent years. Invasions have become more frequent, their range has expanded and their effects have become more severe. Over the past ten years, one or two new IAS have entered the country every year on average. In 2014, China documented the presence of 544 IAS. Because they are usually difficult to control and hence have irreversible effects, IAS are considered to be the biggest biological threat to the country's ecosystems of relevance to food and agriculture. IASs have caused serious losses to agriculture, forestry, animal husbandry and fisheries, and also threaten human health. For example, the spread of *Solidago canadensis* in the Shanghai area resulted in the disappearance of more than 30 native plant species. Five of the 17 unique and economically important indigenous fish species of the Erhai lake in the Province of Yunnan became endangered following the introduction (in some case intentional and in others unintentional) of 13 alien fish species. The introduced fish species affected the lake's ecosystem balance by, *inter alia*, competing with the indigenous species for food and spawning grounds and predating on them.

Most reporting countries indicate that knowledge on the effects of IAS on biodiversity for food and agriculture is still very limited and that their management needs to be improved. Advancing work in this field will require better coordination at the national level, as well as adequate financial mechanisms.

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

1.2.3 National information systems on associated biodiversity

Overall, associated biodiversity species are less systematically monitored in the region than animal (livestock), plant (crop), forest and aquatic genetic resources.

Most countries have established red lists to monitor the status and trends of native flora and fauna species and the threats that affect them. These lists are based on the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN) and are reviewed at regular intervals. While information is recorded on the ecosystems in which the monitored species occur (including agricultural, forest and marine ecosystems) no information is recorded on their functions within these ecosystems.

China reports that it has established 2 389 stations across the country in recent years for long-term monitoring of, *inter alia*, forests and coastal and marine ecosystems. India mentions that it monitors pests and diseases in biodiversity hot spots and crop production systems through exploratory surveys. It also notes that several agencies monitor micro-organisms, parasites and pests in the livestock sector. Bangladesh indicates that it monitors some species associated with plants, livestock and fish through its Agriculture Information System. It also mentions that the few existing research activities on associated biodiversity conducted in the country have mostly been undertaken on a project basis and that it lacked the funds needed to undertake baseline surveys of components of associated biodiversity. Viet Nam's Ministry of Natural Resources and Environment carried out a four-year project in collaboration with the Japan International Cooperation Agency (JICA), entitled Formulation of the National Database on Biodiversity. The project aimed to develop a structure for Viet Nam's future national biodiversity database system and to build capacity to ensure the sustainable management and utilization of the system. Nepal and Sri Lanka indicated that they have no specific monitoring systems in place to assess the status and trends of associated biodiversity. Nepal does, however, mention that the Information Desk of its Ministry of Forest and Soil Conservation gathers data that could be of relevance.

1.2.4 Associated biodiversity actively managed for the provision of ecosystem services

The associated biodiversity species most frequently reported by countries in Asia to be actively managed for the provision of ecosystem services are listed in Table 3.

Table 3. Associated biodiversity species most frequently reported to be managed for the provision of ecosystem services in Asia

Ecosystem service	Species/other taxonomic group	Countries where species are reported
Pollination	Honey bees: Eastern honey bee (*Apis cerena*) European honey bee (*Apis mellifera*) Bumble bees (*Bombus* spp.) Stingless bees (*Trigona* spp.)	Bangladesh, Bhutan, Sri Lanka
Pest and disease regulation	Aquatic animals: - Guppy (*Poecilia reticulata*) - Tilapia: Nile tilapia (*Oreochromis niloticus*), Mozambique tilapia (*O. mossambicus*) and redbreast tilapia (*Tilapia rendalli*) - Whiteleg shrimp (*Litopenaeus vannamei*) Insects: - Ladybirds (Coccinellidae) Fungi: - *Beauveria bassiana* - *Metarhizium anisopliae* - *Trichoderma* spp. Bacteria: - *Azoto chroococcum* - *Azospirillum brasilense* - *Bacillus subtilis* - *Bacillus thuringiensis* - *Pseudomonas fluorescens* - *Rhizobium*	Bangladesh, India, Sri Lanka
Water purification and waste treatment	Fish: - Guppy (*Poecilia reticulata*) - Indian carp (*Cyprinus catla*) - Tilapia: Nile tilapia (*Oreochromis niloticus*), Mozambique tilapia (*O. mossambicus*) and redbreast tilapia (*Tilapia rendalli*) Trees: - Birch (*Betula* spp.) - Dryland willow (*Salix matsudana*) - Chinquapin (*Castanopsis*) - *Cyclobalanopsis* (subgenus of *Quercus*) - Lilac (*Syringa vulgaris*) - Masson pine (*Pinus massoniana*) - Spruce (*Picea* spp.)	China, India, Sri Lanka
Nutrient cycling	Fish: - Indian carp (*Cyprinus catla*) - Tilapia Green manure crop: - Dhaincha (*Sesbania aculaeta*) Invertebrates: - Dung beetles (Scarabaeidae) - Earthworm (*Lumbricus terrestris*) - Termites (Isoptera) Livestock: - Buffalo, cattle, chauries, goats, sheep (e.g. Jaffna, an indigenous Sri Lankan breed) and yaks Trees: - Manchurian walnut (*Juglans mandshurica*) - Scots pine (*Pinus sylvestris*)	Bhutan, China, India, Nepal, Sri Lanka

Table 3 *Cont'd*

Ecosystem service	Species/other taxonomic group	Countries where species are reported
Soil formation and protection	Cover crops: - Riverhemp (*Sesbania* spp.) Mycorrhizal fungi Trees: - Acacia - Arborvitae - Chinese pine (*Pinus tabuliformis*) - Poplar (*Populus* spp.) - Sea buckthorn (*Hippophae rhamnoides*)	Bangladesh, China
Habitat provisioning (forest ecosystems)	Wild animals: Tiger, snow leopard, elephant Trees: - Acacia - Arborvitae - Cork oak (*Quercus suber*) - Larch (*Larix* spp.) - Masson pine (*Pinus massoniana*)	Bhutan, China
Natural hazard regulation (landslides)	Fodder species: - Gautemala (*Tripsicum luxom*) - Napier grass (*Panesitum purpureum*)	Bhutan
Production of oxygen, gas regulation	Fish: - Carp: Common carp (*Cyprinus carpio*), Indian carp (*Catla catla*), Rohu (*Labeo rohita*), mrigal carp (*Cirrhinus mrigala*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and bighead carp (*Hypophthalmichthys nobilis*) - Tilapia: Nile tilapia (*Oreochromis niloticus*), Mozambique tilapia (*O. mossambicus*) and redbreast tilapia (*Tilapia rendalli*) Trees: - Acacia - Dryland willow (*Salix matsudana*) - Sea buckthorn (*Hippophae rhamnoides*)	China, Sri Lanka

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

1.2.5 Wild food species

The wild food species most frequently reported by countries in Asia are listed in Table 4.

Table 4. Wild food species reported by three or more countries in Asia

Wild food species	Countries where species are reported
Plants	
Asparagus: Shatavari (*Asparagus racemosus*) and Sicklethorn (*A. falcatus*)	Bhutan, Nepal, Sri Lanka
Fat hen (*Chenopodium album*)	Bangladesh, India, Nepal
Gorgon nut (*Euryale ferox*)	Bangladesh, India, Nepal
Indian lotus (*Nelumbo nucifera*)	Bangladesh, India, Nepal
Yam: white yam (*Dioscorea alata*) and air potato (*D. bulbifera*)	Bangladesh, Bhutan, India, Nepal, Sri Lanka, Viet Nam
Amaranth (*Amaranthus* spp.)	Bangladesh, India, Nepal, Viet Nam
Taro (*Colocasia esculenta*)	Bangladesh, India, Viet Nam
Vegetable fern (*Diplazium esculentum*)	Bhutan, Bangladesh, Nepal, Viet Nam
Raspberry (*Rubus* spp.), including the yellow Himalayan raspberry (*R. ellipticus*)	India, Nepal, Viet Nam
Bauhinia trees: Maloo creeper (*Bauhinia vahlii*), orchid tree (*B. variegata*) and white orchid tree (*B. viridescens*)	Bangladesh, India, Nepal, Viet Nam
Garcinia spp.	Bangladesh, India, Sri Lanka, Viet Nam
Wild mangoes: mango (*Mangifera indica*), Himalayan mango (*M. Sylvatica*) and Sri Lanka wild mango (*M. zeylanica*)	Bangladesh, Nepal, Sri Lanka, Viet Nam

Table 4 *Cont'd*

Wild food species	Countries where species are reported
Fig trees: Indian fig tree (*Ficus racemosa*), hairy fig tree (*F. hispida*), Roxburgh fig tree (*F. auriculata*)	Bangladesh, Nepal, Viet Nam
Diospyros spp., including Malabar ebony (*D. malabarica*)	Bangladesh, China, Nepal, Viet Nam
Artocarpus spp., including monkey fruit (*A. lakoocha*)	Bangladesh, India, Nepal, Sri Lanka
Indian gooseberry (*Phyllanthus emblica*)	Bangladesh, India, Nepal, Sri Lanka, Viet Nam
Ceylon wood (*Manilkara hexandra*)	Bangladesh, India, Sri Lanka
Fish	
Catfish: butter catfish (*Ompok bimaculatus*) and stinging catfish (*Heteropneustes fossilis*)	Bangladesh, India, Sri Lanka, Viet Nam
Climbing perch (*Anabas testudineus*)	Bangladesh, Sri Lanka, Viet Nam

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

1.3 Needs and priorities

Needs and priorities in terms of the assessment and monitoring of plant, animal, forest and aquatic genetic resources are largely covered in the respective sectoral state of the world reports. This section therefore essentially focuses on the needs and priorities of relevance to associated biodiversity.

With the exception of China, none of the reporting countries seem to have engaged in systematic monitoring activities for associated biodiversity. Most countries report that there is a need to undertake surveys to gather baseline data on the status and trends of associated biodiversity. This would, however, require long-term funding and skilled human resources, both of which seem to be lacking in the region.

Overall, the state of wild food resources in the region is not well recorded. Countries note the need for an inventory of wild food species, as well as for the development of plans and strategies to ensure their conservation and sustainable use. This will require political commitment, technical skills, equipment and financial resources, all of which are currently in short supply.

Bangladesh mentions that wild food species have been used by rural communities across the region for centuries, but that there are still no organized programmes or projects in place to highlight the value of these species to food and nutrition. It also mentions that the decline of many wild edible plant species as a result of the expansion of agricultural lands, development projects, etc. means that there is an urgent need to develop breeding programmes and other activities that maintain and sustainably use such species. India indicates that, as its fisheries sector still largely depends on wild fish stock, knowledge generation on the productive value and conservation of wild fish genetic resources is considered a priority.

Several countries report that natural and human-made disasters have affected BFA, but that the extent of their effects is not being systematically documented. To facilitate data gathering in this field, Bangladesh mentions the need to strengthen institutional capacities, for example by establishing a national body or agency focusing on BFA. India highlights the need for modalities for the reintroduction of lost or threatened local genetic resources into disaster-struck areas.

II. Sustainable use and conservation of biodiversity for food and agriculture

2.1 SUSTAINABLE USE

2.1.1 Management practices supporting the maintenance and use of biodiversity for food and agriculture

Table 5 summarizes reported trends in the adoption of selected management practices that countries were invited to report on, and lists additional measures reported to be taken to support the sustainable use of associated biodiversity and/or wild foods and where available indicates reported trends.

Table 5. Reported trends in the adoption of selected management practices and approaches in Asia

Practice or intervention	Production system	Country reporting	Reported trends in adoption[1]
Agroforestry	Livestock grassland-based[2], Livestock landless[3], Naturally generated forests, Planted forests, Self-recruiting capture fisheries, Culture-based fisheries, Irrigated crops (rice and other), Rainfed crops	Bangladesh, China, Nepal, Viet Nam	Generally positive, negative in livestock grassland-based, and in irrigated crops (Bangladesh)
Base broadening	Livestock grassland-based, Livestock landless, Naturally generated forests, Planted forests, Self-recruiting capture fisheries, Culture-based fisheries, Irrigated crops (rice and other), Rainfed crops, Mixed	Bangladesh, Bhutan, China, India, Nepal, Viet Nam	Generally positive to strongly positive, negative for rainfed crops (Bhutan)
Conservation agriculture	Livestock grassland-based, Livestock landless, Naturally generated forests, Planted forests, Irrigated crops (rice and other), Rainfed crops	Bangladesh, Nepal, Viet Nam	Stable to strongly positive
Conservation farm and conservation area	Livestock grassland-based	China	Strongly positive
Diversification	Livestock grassland-based, Livestock landless, Naturally generated forests, Planted forests, Self-recruiting capture fisheries, Fed aquaculture, Culture-based fisheries, Irrigated crops (rice and other), Rainfed crops, Mixed	Bangladesh, Bhutan, China, India, Nepal, Viet Nam	Generally stable to strongly positive Strongly negative for self-recruiting capture fisheries (Bangladesh and Viet Nam), negative in rainfed crops in Bhutan
Domestication	Livestock grassland-based, Livestock landless, Naturally generated forests, Planted forests, Self-recruiting capture fisheries, Culture-based fisheries, Fed aquaculture, Irrigated crops (rice and other), Rainfed crops, Mixed	Bangladesh, Bhutan, China, India, Nepal, Viet Nam	Stable to strongly positive
Ecosystem approach to capture fisheries	Self-recruiting capture fisheries, Culture-based fisheries, Fed aquaculture, Non-fed aquaculture, Irrigated crops (rice and other), Rainfed crops, Mixed	China, Bangladesh, India, Viet Nam	Generally positive to strongly positive Mixed trends in self-recruiting capture fisheries, negative in non-fed aquaculture (Bangladesh)
Enrichment planting	Naturally regenerated forests, Planted forests, Irrigated crops (non-rice), Rainfed crops, Mixed	Bangladesh, China, Nepal, Viet Nam	Stable to positive
Home gardens	Livestock grassland-based, Livestock landless, Naturally generated forests, Planted forests, Culture-based fisheries, Irrigated crops (rice and other), Rainfed crops, Mixed	Bangladesh, India, Nepal, Viet Nam	Generally stable to positive Negative in irrigated crops (rice) (Bangladesh)
Integrated pest management	Livestock grassland-based, Naturally generated forests, Planted forests, Irrigated crops (rice and other), Rainfed crops	Bangladesh, China, Nepal, Viet Nam	Strongly positive
Integrated plant nutrient management	Livestock landless, Naturally generated forests, Planted forests, Irrigated crops (rice and other), Rainfed crops	Bangladesh, China, Nepal, Viet Nam	Stable to strongly positive

Table 5 *Cont'd*

Practice or intervention	Production system	Country reporting	Reported trends in adoption[1]
Landscape management	Livestock grassland-based, Naturally generated forests, Planted forests, Self-recruiting capture fisheries, Culture-based fisheries, Irrigated crops (rice and other), Rainfed crops	Bangladesh, Nepal, Viet Nam	Generally positive Negative in irrigated crops (other) (Bangladesh)
Livestock improvement and health management	Livestock grassland-based, Livestock landless, Mixed	India	Positive
Low external input agriculture	Livestock landless, Naturally generated forests, Planted forests, Culture-based fisheries, Irrigated crops (rice and other), Rainfed crops	Bangladesh, China, Nepal, Viet Nam	Stable to positive
Management of micro-organisms	Livestock grassland-based, Livestock landless, Naturally regenerated forests, Planted forests, Culture-based fisheries, Irrigated crops (other), Rainfed crops, Mixed	Bangladesh, India, Viet Nam	Positive to strongly positive
Organic agriculture	Livestock landless, Naturally generated forests, Planted forests, Self-recruiting capture fisheries, Culture-based fisheries, Irrigated crops (rice and other), Rainfed crops	Bangladesh, Nepal, Viet Nam	Stable to positive
Pollination management	Livestock landless, Naturally generated forests, Planted forests, Irrigated crops (rice and other), Rainfed crops	Bangladesh, Nepal, Viet Nam	Stable to strongly positive
Polyculture/aquaponics	Culture-based fisheries, Fed aquaculture, Non-fed aquaculture, Irrigated crops (rice and other), Rainfed crops	Bangladesh, India, Viet Nam	Stable to positive
Reduced-impact logging	Naturally generated forests, Planted forests, Irrigated crops (other), Rainfed crops	China, Viet Nam	Positive
Restoration practices	Livestock grassland-based, Naturally regenerated forests, Planted forests, Self-recruiting capture fisheries, Irrigated crops (rice and other), Rainfed crops, Mixed	Bangladesh, Bhutan, China, Viet Nam	Positive
Sustainable soil management practices	Livestock grassland-based, Naturally generated forests, Planted forests, Irrigated crops (rice and other), Rainfed crops	Bangladesh, Nepal, Viet Nam	Stable to strongly positive

[1] Some countries were not able to indicate the trend in the application of the practice.
[2] Integrated pest management and pollination management are considered by some countries to have negative effects on biodiversity for food and agriculture in grassland-based and landless livestock systems.
[3] Conservation agriculture, water management practices and water harvesting are considered by some countries to have negative effects on biodiversity for food and agriculture in landless livestock systems.
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

2.1.2 Effect of diversity *per se* on productivity, food security and nutrition, and rural livelihoods

Sri Lanka reports that its commercial poultry production is largely based on improved exotic breeds; domestic breeding of local poultry breeds almost completely ceased at the end of the 1990s. Like other countries in the region, Sri Lanka has no local commercial poultry breeds/lines to fall back on in the event of a critical situation (e.g. unforeseen disease outbreaks).

China reports that the forests in the country's Western Hunan Province are exceptionally rich in biodiversity. The increased use of local fruit and other plant species found in these forests (e.g. papaya, kiwi and wild edible and medicinal plants), as well as the development of other forest-related activities of economic value (e.g. livestock keeping), has led to the development of local enterprises in various areas of the province, including in Xiangxi. The country report suggests that with adequate planning this forest biodiversity could be even more optimally and sustainably utilized, positively contributing to the incomes and food security of local communities while respecting the environment.

India notes the positive effects of aquatic species diversification on the nutritional content of the food supplied by capture fisheries and fed-aquaculture. It also refers to the importance of its rich diversity of native cattle, buffalo, goat, sheep, pig, equine, camel, yak, mithun and poultry breeds. Being adapted to a variety of extreme weather and climatic conditions, as well as to limited resource availability, these breeds greatly contribute to the resilience of livestock

Box 3. Programmes supporting biodiversity-based and biodiversity-friendly management practices: examples from Bangladesh, China, Nepal and Sri Lanka

In Bangladesh, the application of integrated pest management (IPM) and integrated crop management (ICM) practices, as well as organic agriculture, are reported to positively affect the status of biodiversity, and of associated biodiversity in particular, both within and around crop production systems.

China strongly promotes agroforestry practices, including interplanting of grains, medicinal plants and other crops. Such practices have contributed, *inter alia*, to reducing the impact of natural disasters on grains and improving their yields. In Gaoyi County, in Heibei Province, tree planting in agroforestry systems increased forest coverage from 1.8 percent to 12.8 percent in six years.

In Nepal, management practices that seem to favour the maintenance and sustainable use of biodiversity for food and agriculture include IPM, integrated plant nutrient management, landscape, sustainable soil and water management, conservation agriculture, water harvesting, agroforestry, organic and low external input agriculture and home gardens. These practices are increasingly being adopted across all production systems, especially in the country's mid hill region. Governmental and non-governmental institutions provide farming communities with training on how to apply these practices.

In Sri Lanka, the Department of Agriculture distributes "True Sri Lanka rasaya" seed packs to encourage the cultivation of traditional vegetable varieties in organic home gardens and reduce the use of chemical fertilizers and pesticides.

Source: Adapted from the country reports of Bangladesh, China, Nepal and Sri Lanka.

production systems. The diversity of livestock and of 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. In India, crop–livestock mixed-farming systems are reported to play a particularly important role in nutrient recycling, which is a critical part of sustainable farming. In such production systems, crop residues (e.g. cereal straws and maize and sorghum stover) are generally used as animal feed and livestock manure is used as fertilizer. The benefits of these practices include an increase in crop production and a decrease in the application of chemical fertilizers.

2.1.3 Use of biodiversity for food and agriculture for coping with climate change, invasive alien species and natural or human-made disasters

Countries provided a number of examples of the use of biodiversity for food and agriculture as part of their efforts to address climate change, invasive alien species or disasters of various kinds. This information is summarized in Table 6.

Table 6. Reported examples of the use of biodiversity for food and agriculture to cope with climate change, invasive alien species or natural or human-made disasters in Asia

Objective	Country	Description
Use of biodiversity for food and agriculture (BFA) to adapt to and mitigate climate change	Sri Lanka	**Plant genetic resources** Sri Lanka hosts many crop wild relatives (CWR), including of rice. It reports having identified 410 CWR species in farmers' holdings, forests and wetlands. This diverse gene pool can be used in crop-breeding programmes to enhance crop production and food security. In the context of climate change, high crop genetic diversity is a key resource for adaptation.
	Nepal	**Animal genetic resources** The diversity of indigenous livestock breeds maintained in traditional farming systems offers opportunities for adapting to climate change, including through genetic improvement. **Plant, animal and forest genetic resources** To address the effects of climate change and improve the sustainability and resilience of various production systems, Nepal is implementing national and local adaptation plans of action. The country also has crop- and livestock-specific national research programmes, including breeding activities to develop climate–resilient varieties and breeds.

Table 6 *Cont'd*

Objective	Country	Description
		Plant genetic resources 1. There is an increasing interest in neglected and underutilized crops, both for export and domestic markets, because of their potential contribution to agricultural diversification, climate change adaption and land-use improvement. 2. The Seed Vision of Nepal programme focuses on the conservation and utilization of plant diversity. It supports the use of local germplasm in varietal development, ensuring seed security and increasing productivity. 3. Community seed banks have facilitated farmers' access to a broader range of crop genetic resources and seeds and have thereby contributed to improving local food security. Besides ensuring the conservation and use of plant diversity on-farm, they have also enhanced farmers' seed systems and strengthened social seed exchange networks. The latter are becoming increasingly important in efforts to cope with climate change, as they facilitate immediate access to locally adapted germplasm. **Forest genetic resources** Forest genetic resources also play a crucial role in climate change mitigation and adaption. The use of genetic diversity in forest management can help to reduce the risks associated with climate change.
Use of BFA to manage the spread of/control invasive alien species	Nepal	**Aquatic genetic resources** Several studies on controlling invasive tilapia using native golden mahseer (*Tor putitora*) as predators have been undertaken, with partial success.
	China	**Plant genetic resources** In Sichuan, Yunnan, Guizhou and other places, scientists recently found several native plant species that are able to halt or resist the invasion of exotic species. These species could be part of new prevention and control measures for invasive alien species. For example, non-invasive substitute plant species could be used to prevent the exotic Crofton weed (*Eupatorium adenophorum*) from invading arable areas in the absence of local crop varieties during the dry seasons in autumn and winter.
Use of BFA to prevent natural or human-made disasters and/or reduce their effects on livelihoods, food security and nutrition	Bangladesh	**Plant genetic resources** 1. Natural disasters (e.g. Cyclones Aila and Sidr) can cause severe soil salinization. Researchers have identified saline-tolerant varieties of rice and other crops. These tolerant varieties have been multiplied and the seeds supplied to farmers in the affected areas. 2. In some areas, arum, water lilies and other wild food species are used following natural calamities to compensate food shortages.
	India	**Genetic resources for food and agriculture** In eastern Uttar Pradesh, a consortium of 20 non-governmental organizations compiled agricultural knowledge and practices that have helped communities to respond to floods. These include: - Intensification: Crop intensification has helped to ensure the availability of some crops and income during floods. Other activities include the establishment of grain and seed banks, vegetable growing, fish culture, fodder production and livestock rearing. - Diversification: The diversity of crop and grass varieties, tree species and animal breeds, as well the diversity of people's knowledge, skills, experiences and enterprises, helps farmers to adapt to flooding. When silt and sand spreads over paddy fields, watermelons, gourds and other vegetables and fruits are grown. The landless are able to make a living from backyard farm animals. - Crop-cycle management: Farmers have adopted various strategies to cope with floods, including early planting of crops to harvest before the floods, planting crops that withstand floods and growing late crop varieties to harvest after the floods. Indigenous technical knowledge is an integral part of the above-listed flood adaptation practices.

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

Box 4. Management of plant, animal, forest and aquatic genetic resources for the delivery of regulating and supporting ecosystem services: examples from Viet Nam

In many provinces, the Government of Viet Nam has implemented agroforestry programmes to reduce the adverse impacts of climate change. These programmes focus on:

- Soil formation and protection/erosion regulation: Multiple plants and multiple canopy layers help to decrease soil erosion and protect soils; crop residues and organic material from trees, such as leaves and fruit, contribute to soil formation and improvement.
- Water cycling: Systems that feature multilayer vegetation and green fences are good at retaining water and thus require less irrigation than monoculture systems.
- Pest and disease regulation: Combining several tree cultivars reduces the use of pesticides.

Source: Adapted from the country report of Viet Nam.

2.1.4 Ecosystem, landscape and seascape approaches for the management and use of biodiversity for food and agriculture

Fewer than half of the reporting countries indicated that they had adopted landscape, seascape or ecosystem approaches, including the ecosystem approach applied to fisheries. Several countries reported that they considered the development and application of such approaches to be a priority, in particular in agricultural production systems. They expressed the need for guidelines and action plans to assist them in the development of relevant policies and strategies. Ecosystem, landscape and seascape approaches mentioned by reporting countries as having improved the management of BFA are listed in Table 7.

Table 7. Ecosystem, landscape and seascape approaches reported to have improved the management and use of biodiversity for food and agriculture in Asia

Objective	Country	Description
Use of ecosystem and landscape/seascape approaches to cope with climate change	Bangladesh	**Enhanced Coastal Fisheries (ECOFISH[BD])** ECOFISH[BD] is a five-year initiative, funded by USAID and implemented by WorldFish in partnership with Bangladesh's Department of Fisheries and other stakeholders, that aims to improve the resilience and governance of the Padma-Meghna river-estuarine ecosystem. The project aims to support the use of science-based decision-making in fisheries management, enhance the resilience of hilsa herring (*Tenualosa ilisha*) populations through co-management of the fishery, and build the capacity of partners and fishing communities to improve enforcement in fish sanctuaries. In addition, the project aims to support the livelihoods of fishers, especially women. The project is expected to contribute to: (i) a sustainable supply of hilsa; (ii) improved nutrition, income and quality of life for small-scale fishing communities; and (iii) healthy coastal and marine ecosystems that support essential ecosystem services. (http://pubs.iclarm.net/resource_centre/2015-38.pdf) **Climate-Resilient Ecosystems and Livelihoods Project (CREL)** CREL serves three regions of Bangladesh: the northeast wetlands and forests; the southwest Sundarbans mangrove forest; and the southeast forests and coastal wetlands. The project aims to address environmental, socio-economic and policy issues that threaten protected areas and surrounding landscapes. Among other activities, CREL promotes co-management, including, but not limited, to community-based management, of natural resources and biodiversity. It also provides training in natural resource-management and resilience to climate change to co-management organizations and vulnerable, resource-dependent populations. (https://www.winrock.org/project/improving-livelihoods-and-the-environment-in-bangladesh/)
	Nepal	**Climate regulation** Nepal has many different types of livestock production systems in different climatic zones. These production systems play an important role as providers of supporting ecosystem services such as nutrient recycling, climate regulation and habitat provisioning.
	Viet Nam	**Mainstreaming Ecosystem-based Approach to Climate Change into Biodiversity Conservation Planning** This project aimed, *inter alia*, to develop and implement activities for the conservation of biodiversity, strengthen public participation and national and international cooperation, mainstream biodiversity into socio-economic development planning and into strategies for coping with climate change, and complete the legal framework for the conservation of biodiversity. **Developing and Implementing Climate Change Ecosystem-based Adaptation** This framework was designed to assess the vulnerability of socio-ecological systems to climate and non-climate related changes. It supports policy-makers, organizations and individuals by providing tools and methods that can be used to adapt to climate change more effectively.
		Strategic Mainstreaming of Ecosystem-based Adaptation in Viet Nam for the Period 2014–2018 The project aims to strategically integrate the ecosystem-based adaptation (EbA) approach into climate adaptation policies and in land use and development planning. In September 2015 a National Conference on Ecosystem-based Adaptation, From Concept to Practice was organized. The Conference's proceedings help policy-makers formulate EbA plans and advance climate-resilient development. (https://www.giz.de/en/worldwide/27863.html)

Table 7 *Cont'd*

Use of ecosystem and landscape/seascape approaches in the management of wetlands	Bangladesh	**The Wetland Biodiversity Rehabilitation Project** The project aims to strengthen the participation of local communities in decision-making processes for wetland management. With the help of non-governmental organizations, community-based organizations (CBOs) have been established, bringing together representatives from adjacent villages that share the same wetland or floodplain areas to analyse local wetland issues and to reduce conflicts related to the management of natural resources through participatory planning. CBOs facilitate communication and negotiation between communities and government officials. The project also: (i) promotes a range of different business opportunities to maintain and create jobs, both within and outside the fisheries sector; and (ii) helps identify and provides training to farmers on traditional crops and practices that are suitable for use in wetlands. (https://snrd-asia.org/download/wetland_biodiversity_rehabilitation_project/Factsheet.pdf) **Management of Aquatic Ecosystems through Community Husbandry (MACH)** MACH advocates sustainable wetland resource management through multidisciplinary and participatory planning, implementation and monitoring. Within the framework of the programme, resource management organizations (RMOs), each of which represents all the stakeholder groups for a particular part of the wetland system, were established. In their respective areas, the RMOs have worked to protect water bodies and address problems identified by communities. This has involved setting rules for, and limits on, the use of wetlands and restoring wetland habitats, including through tree planting. To offset the hardships caused by fishing restrictions, poor households have received skills training and microloans to enable them to start new enterprises. The MACH programme's success is rooted in community ownership. (https://sustainabledevelopment.un.org/partnership/?p=2022) **Coastal and Wetland Biodiversity Management (CWBM)** The project, which ended in 2010, was located at Hakaluki Haor, one of the largest and most important freshwater areas in the country. The overall objective of the CWBM Project was to establish an innovative system for the management of Ecologically Critical Areas (ECAs) in Bangladesh to maintain and ensure the long-term viability of the country's biodiversity. Key achievements of the project include plantation and regeneration of mangroves, plantation of indigenous fruit and timber-yielding tree species, ecofriendly shrimp-fry collection, improvement of livelihoods and awareness-raising about the conservation and management of local biodiversity and natural resources. (https://www.thegef.org/project/coastal-and-wetland-biodiversity-management-coxs-bazar-and-hakakuki-haor)
Use of ecosystem and landscape/seascape approaches to prevent natural or human-made disasters and/or reduce their effects on livelihoods, food security and nutrition	Viet Nam	**Agroforestry** is one of the best approaches to dealing with deforestation, a human-made disaster that has led to landslides, floods and the loss of soil fertility. It enhances the use of biodiversity and improves the livelihoods of people living near forests - **Traditional agroforestry systems**, include the fallow/shifting cultivation system, the forest and terrace system, the garden-fish pond-livestock system, the forest-garden-fish pond– livestock system, and the forest–cash crops–paddy rice system. - **Innovative agroforestry systems**, include the alley-cropping system, green fence/boundary planting; windbreaks and shelterbelt systems, and Taungya, a system in which seasonal crops are grown in the free space between newly planted trees.
		Viet Nam has adopted disaster-risk reduction adaptation strategies with two priority areas: sound mangrove management; and the development of alternative activities for the sustainable livelihoods of local communities. Sustainably managed mangroves contribute to reducing the impacts of storms, rising sea levels and tsunamis. They also provide habitats for juvenile fish, crustaceans (e.g. shrimp and crabs) and molluscs (e.g. oysters and mussels). These aquatic species are used, *inter alia*, for home consumption and to sell. Mangrove forests also provide other essential goods, such as honey, timber and fuelwood. Upstream forest cover is being increased to reduce the impact of flooding

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

2.1.5 Activities promoting the maintenance and use of traditional knowledge of associated biodiversity and wild foods

The roles of indigenous peoples and gender in the management of biodiversity for food and agriculture and its associated knowledge

The country report from Nepal notes that about 35 percent of all vegetables consumed in Nepalese households are collected from forests and bushes. These highly nutritious wild plants are important to the livelihood of rural communities, particularly prior to the harvest of staple foods and during natural disasters and periods of food deficiency. However, they tend to be neglected in sustainable use and conservation programmes. The report mentions that local communities have expressed a strong desire to establish community-based enterprises based on wild-food resources for long-term income generation. Most knowledge about gathering locations and seasonality, preservation, processing and culinary uses of local plant varieties, which could play an important roles in the conservation and potential commercialization of indigenous vegetables, is reported to be held by rural women and indigenous communities.

In 1997, with the support of FAO, the M.S. Swaminathan Research Foundation conducted a research project on gender dimensions in biodiversity management in different locations throughout India. It found that women and men have different knowledge, needs and roles with regard to the conservation and use of BFA, mainly because they undertake different activities in agricultural production. While men are generally in charge of land preparation (e.g. clearing and soil tilling), women are responsible for sowing, hoeing, crop maintenance, harvesting, food processing, storage and seed selection for future planting. Traditionally, women are the caretakers of genetic diversity in agriculture, while men tend to be more concerned with converting these resources into cash.

The country report from China notes that the crucial role of women in protecting BFA is closely related to their roles in the family, community and agricultural production. Women have considerable decision-making power in agricultural production, including with respect to the selection and breeding of local crop varieties, intercropping, control of pests and diseases, and fertilizer use. Their involvement in agriculture thus has a significant impact on the conservation and use of BFA. Women also promote the conservation of biodiversity at community level through their engagement in village affairs.

Traditional knowledge and the use of biodiversity for food and agriculture

The country report from Sri Lanka notes that traditional knowledge of the various uses of local and indigenous plant material for medicinal purposes could prove to be invaluable to modern medicine and to the development of the country's local pharmaceutical industry. Some indigenous plant species are already being used in commercially available medicinal and dietary products. However, patents related to these uses are mostly held outside the country, as are the resulting benefits. The report from China also refers to the importance of knowledge related to genetic resources in traditional medicine and mentions the country's Intangible Cultural Heritage Law. It also notes that in 2004 an *Atlas of Chinese Herbal Medicine and Ethnic Medicinal Herbs* was prepared within the framework of the project Collection, Collation and Preservation of Herbal and Ethnic Medicine Specimens.

The report from India notes that various traditional and religious practices used by the country's tribal and other local communities contribute to the conservation of BFA. For example, several tribes contribute to the conservation of dammer bees through the use of traditional beekeeping methods. In 2000, the Government of India established the National Innovation Foundation to strengthen the use of traditional knowledge and grassroots technological innovations. The country also recognizes the importance of maintaining and documenting traditional knowledge. Across India, different institutions have documented the traditional knowledge of fisherfolk in major aquatic ecosystems, while information on Ayurveda, a traditional system of Indian medicine, is stored in the Traditional Knowledge Digital Library. Various legal instruments have been

developed to protect traditional knowledge, including the Geographical Indication of Goods Act of 1999 and the Protection of Plant Varieties and Farmers' Rights Act of 2001. Nepal reports that it has developed a number of information systems to document traditional knowledge on BFA. None of these systems are reported to have a particular focus on traditional knowledge related to the use of associated biodiversity.

2.1.6 Needs and priorities

Several country reports note that more research is needed to identify the effectiveness of management practices that are believed to favour the maintenance and use of BFA. They also mention that relevant results in this field should be made available to policy-makers and farmers.

Several countries express the need to promote the adoption of ecosystem approaches in agricultural production systems, noting also that this could be facilitated through the development of guidelines and action plans. However, most countries mention that a lack of human, technological, infrastructural and financial resources constrains progress in this field. India notes that the implementation of ecosystem approaches is a priority for the conservation and sustainable use of BFA. It reports that it plans to apply such approaches in ecologically fragile areas that contain high levels of genetic diversity, for example in gene sanctuaries, national parks and forest reserves in the northeastern and northwestern Himalayas and the Western Ghats. It is expected that this will contribute to the conservation of, *inter alia*, crop wild relatives and neglected and underutilized crops, some of which may prove to be important in future crop production thanks to their ability to tolerate various environmental stresses. Sri Lanka notes that its exceptional endemic richness in BFA represents a huge potential for bioprospecting, in particular for pharmaceutical and cosmetic applications. Opportunities of this kind have not yet been adequately explored.

2.2 CONSERVATION

2.2.1 *In situ* conservation

The importance of *in situ* conservation is acknowledged by all the reporting countries. Countries note that protected areas are important to the conservation both of wild food species and of associated biodiversity. For example, Bhutan reports that more than 50 percent of its territory is covered by protected areas. In some of these areas, conservation programmes for emblematic endangered species such as tigers, snow leopards and elephants are being implemented both to protect the species and to ensure their roles in habitat provisioning are maintained. Protected areas are also reported to play an important role in the conservation of wild foods in Afghanistan and Viet Nam. Bangladesh mentions that protected areas contribute to the conservation of forests, mangroves and freshwater wetlands. It reports that it has 37 protected areas that particularly focus on conserving the diversity of forest ecosystems. Viet Nam reports that it has established a series of special-use forests to protect rare forest-tree species. It also mentions that six ministries jointly established a national conservation system involving both *in situ* and *ex situ* conservation programmes for animal, plant, forest, aquatic and micro-organism genetic resources. Several countries refer to the importance of home gardens as sites of *in situ* conservation.

Countries report that there is a need to strengthen *in situ* conservation efforts for BFA by reinforcing existing initiatives and developing new programmes and strategies. Some countries mention that raising awareness and strengthening the involvement of local stakeholders in *in situ* conservation efforts should be prioritized. Protected areas are considered important by most countries for *in situ* conservation of BFA, and of wild food species in particular. Managing these areas requires funding and human resources, both of which seem to be lacking across the region.

Viet Nam is continuing to expand its broad network of protected areas, including national parks, nature reserves, cultural and historical sites and "special-use" forests, which are home to

Table 8. Examples of protected areas in Asia with *in situ* conservation initiatives for associated biodiversity and wild foods

Country	National park/protected area	Target species for conservation
Afghanistan	Big Pamir	Alpine vegetation: Ericaceae, grasses, *Primula marcophyla*
	Ab-i-Estada	Steppe vegetation: *Amygdalis* spp., *Cousinia* spp., tamarisk (*Tamarix* spp.), *Artemisia* spp.
	Ajar valley	Willow (*Salix* spp.), tamarisk (*Tamarix* spp.), *Ephedra* spp., beancaper (*Zygophyllum* spp.), *Acantholimon* spp., *Carex stenophylla*, unspecified plant species in meadows and grasslands
	Bande Amir	Willow (*Salix* spp.), horse mint (*Mentha longifolia*), *Acantholimon* spp., *Tulipa* spp., *Allium* spp., *Gagea* spp., buttercup (*Ranunculus* spp.)
	Hamun-i-Puzak	Common reed (*Phragmites australis*), *Artemisia* spp., tamarisk (*Tamarix* spp.), unspecified algae and migratory bird species
	Nurestan	Walnut (*Juglans* spp.), birch (*Betula* spp.), oak (*Quercus* spp.), cedar (*Cedrus* spp.), pine (*Pinus* spp.), juniper (*Juniperus* spp.), unspecified species of alpine shrubs
	Dashte Nawar	Highland steppe vegetation: *Bromus* spp., alkali grass (*Puccinellia* spp.), *Aeluropus* spp., *Acantholimon* spp., sea milkweed (*Glaux maritima*), *Crypsis aculeata*, *Polygonum sibiricum*, unspecified herbaceous plant and algae species
China	Beijing, Tianjin, Hebei, Shanxi, Inner Mongolia, Liaoning, Jilin, Heilongjiang, Shandong, Henan, Shaanxi	Manchurian walnut (*Juglans mandshurica*)
	Guangdong, Guangxi	Longan (*Dimocarpus longan*)
	Guangxi, Guizhou	*Litchi chinensis* var. *euspontanea*
	Tibet	*Cordyceps sinensis*
	Qinghai	*Cordyceps sinensis*
	Yunnan	Pine mushroom (*Tricholoma matsutake*)
	Longjing, Yanbian Korean Autonomous Prefecture, Jilin Province	Pine mushroom (*Tricholoma matsutake*)
	Six townships in Tiane County, Guangxi Province, including Liupai, Yimu, Nazhi, Gengxin, Xiangyang, Xialao, Pojie, Sanbao	Tian'e pheasant
	Taiwan	Formosan sika deer
	Luoshan Mountain of Ningxia	Pheasant
India	Great Nicobar Biosphere Reserve, Andaman and Nicobar Islands	*Areca triandra*, Chinese grass (*Boehmeria nivea*), citron (*Citrus medica*), *Mangifera andamanica*, *M. camptosperma*, Himalayan mango (*M. sylvatica*), beach pea (*Vigna marina*), *Vanilla andamanica*; *Elaeocarpus* spp., *Tinospora* spp., *Haematocarpus* spp., *Garcinia* spp., *Grewia* spp., *Salacia* spp., jujube (*Ziziphus* spp.), *Nephelium* spp., *Buchanania* spp., jackbean (*Canavalia* spp.), riverhemp (*Sesbania* spp.), blackberry (*Rubus* spp.), bush cherries (*Syzygium* spp.), *Coccinia* spp., *Morinda* spp., devil pepper (*Rauvolfia* spp.), basil (*Ocimum* spp.), pepper plant (*Piper* spp.), nutmeg (*Myristica* spp.), *Baccaurea* spp., breadfruit (*Artocarpus* spp.), ginger (*Zingiber* spp.), banana (*Musa* spp.), yam (*Dioscorea* spp.), *Colocasia* spp., Job's tears (*Coix* spp.)
	Seshachalam Biosphere Reserve in Chittoor and Cuddapah districts, Andhra Pradesh	Wild species of *Curcuma* spp., yam (*Dioscorea* spp.), pepper plant (*Piper* spp.), ginger (*Zingiber* spp.), cowpea (*Vigna* spp.), sesame (*Sesamum* spp.), okra (*Abelmoschus* spp.), *Cajanus* spp., *Dunbaria* spp., snoutbean (*Rhynchosia* spp.), pigweed (*Amaranthus* spp.)
	Dihang-Dibang Biosphere Reserve in Dibang Valley, Upper Siang, and West Siang districts, Arunachal Pradesh	*Allium prattii*, *A. rhabdotum*, *Cajanus* spp., *Camellia siangensis*, *Citrus ichangensis*, citron (*C. medica*), *Coptis teeta*, fiveleave yam (*Dioscorea pentaphylla*), *D. wallichii*, *D. prazeri*, *D. wattii*, banana (*Musa* spp.), *Piper attenuatum*, *P. sylvaticum*, *P. hamiltonii*, *P. peepuloides*, plum (*Prunus* spp.), blackberry (*Rubus* spp.), ginger (*Zingiber* spp.), Indian soapberry (*Sapindus mukrosii*), *Rhododendron* spp.

Table 8 *Cont'd*

Country	National park/protected area	Target species for conservation
	Dibru-Saikhowa Biosphere Reserve in Tinsukhia and Dibrugarh districts, Assam	Sunset muskmallow (*Abelmoschus manihot*), *Camellia kissii*, Assam tea (*C. sinensis* var. *assamica*), *Citrus* spp., *Cucumis hystrix*, curcuma (*Curcuma aromatica*), mango ginger (*C. amada*), yam (*Dioscorea* spp.), banana (*Musa* spp.), pepper plant (*Piper* spp.), *Zingiber intermedium*, *Z. rubens*, *Z. spectabile*
	Nilgiri Biosphere Reserve, Tamil Nadu, Kerala and Karnataka	*Hirsute artocarpus* (*Artocarpus hirsutus*), lac tree (*Schleichera oleosa*), *Grewia tiliifolia*, malabar kino (*Pterocarpus marsupium*), giant thorny bamboo (*Bambusa bambos*), male bamboo (*Dendrocalamus strictus*), bush cherries (*Syzygium* spp.), cinnamon (*Cinnamomum* spp.), nutmeg (*Myristica* spp.), pepper plant (*Piper* spp.), true cardamon (*Elettaria cardamomum*), golden shower (*Cassia fistula*), emblic (*Phyllanthus emblica*), myrobalan (*Terminalia chebula* and *T. bellirica*), *Asparagus racemosus*, *Hemidesmus indicus*, serpentine wood (*Rauvolfia serpentine*), black damar (*Canarium strictum*), *Garcinia morella*, *Garcinia gummi-gutta*, *Cinnamomum sulphuratum*
	Pachmahri Biosphere Reserve in Hoshangabad district, Madhya Pradesh	*Abelmoschus tuberculatus*, citron (*Citrus medica*), *Cucumis setosus*, nightshade (*Solanum incanum*), *S. insanum*, *Vigna radiata* var. *sublobata*, wild forms of little millet (*Panicum sumatrense*), kodomillet (*Paspalum scrobiculatum*), rice bean (*Vigna umbellate*)
	Nokrek Biosphere Reserve in West, East and South Garo Hills districts, Meghalaya	*Camellia caduca*, *Citrus indica*, *C. latipes*, citron (*C. medica*), *Cucumis hystrix*, *Prunus jenkinsii*, rice bean (*Vigna umbellata*)
	Similipal Biosphere Reserve in Mayurbhanj district, Odisha	*Abelmoschus crinitus*, *A. manihot* ssp. *tetraphyllus*, Indian long pepper (*Piper longum*), *P. trioicum*, *Solanum insanum*, turkeyberry bush (*S. torvum*), tropical soda apple (*S. viarum*), fiveleaf yam (*Dioscorea pentaphylla*), air potato (*D. bulbifera*), *D. pubera*, Chinese yam (*D. oppositifolia*), Malay ginger (*Cheilocostus speciosus*), *Ziziphus fruticosa*, jujube (*Z. nummularia*), *Z. oenopolia*, *Z. xylopyrus*
	Agasthyamal Biosphere Reserve, Tamil Nadu and Kerala	*Abelmoschus angulosus* (3 taxa), *Cajanus lineatus*, *Solanum insanum*, *S. multiflorum*, *Oryza meyeriana* ssp. *granulata*, snakegourd (*Trichosanthes cucumerina* ssp. *villosula*), *T. nervifolia*, *Vigna sublobata*, *Trichopus zeylanicus*, nutmeg (*Myristica* spp.), *Garcinia imberti*, *Madhuca bourdillonii*, *Syzygium bourdillonii*, false waterwillow (*Andrographis* spp.)
	Nanda Devi Biosphere Reserve in Chamoli, Bageshwar and Pittoragarh districts, Uttarakhand	*Allium stracheyi*, *Aconitum balfourii*, *A. heterophyllum*, *Angelica glauca*, *Arnebia benthamii*, *Dactylorhiza hatagirea*, *Hedychium spicatum*, *Paeonia emodi*, *Picrorhiza kurrooa*, *Podophyllum hexandrum*, costus root (*Saussurea costus*), *S. obvallata*, tejo (*Taxus baccata*)
	Gulf of Mannar Biosphere Reserve Tamil Nadu	Jujube red date (*Zizyphus jujuba*), sesame (*Sesamum* spp.), *Porteresia coarctata*, *Vigna trilobata*, *Solanum surrattense*, colocynth (*Citrullus colocynthis*), toddy palm (*Borassus flabellifer*)
	Manas Biosphere Reserve in Kokrajhar, Chirang, Baksa, Udalguri, and Darrang districts, Assam	Serpentine wood (*Rauvolfia serpentine*), *Oroxylum indicum*, *Paspalum longifolium* var. *lorirhachis*, *Garcinia* spp., myrobalan (*Terminalia chebula*), black plum (*Syzygium cumini*), *S. formosum*, *S. oblatum*, butterfly tree (*Bauhinia purpurea*), Indian bark (*Cinnamomum tamala*), kapok (*Bombax ceiba*), *Ficus roxburghii*, white teak flowers (*Gmelina arborea*), chulta (*Dillenia indica*), ban chalta (*D. pentagyna*), banana (*Musa balbisiana*), *Spondias pinnata*, *Saccharum narenga*, vetiver grass (*Vetiveria zizanioides*)
	Sunderban Biosphere Reserve in 24 Parganas district, West Bengal	Rice (*Oryza* spp.), *Nypa fruticans*, *Porteresia coarctata*, *Grewia*, Indian long pepper (*Piper longum*), *Solanum insanum*, *Ziziphus fruticosa*, jujube (*Z. nummularia*) jackal jujube (*Z. oenoplia*), *Z. xylopyrus*
	Khangchend zonga Biosphere Reserve in West Sikkim district, Sikkim	Indian aconite (*Aconitum ferox*), *A. heterophyllum*, *Bergenia ciliata*, *Dactylorhiza hatagirea*, *Nardostachys jatamansi*, ginseng (*Panax pseudoginseng*), *Swertia chirayita*, tejo (*Taxus baccata*)
	Achanakmar Amarkantak Biosphere Reserve, Chhattisgarh and Madhya Pradesh	*Madhuca indica*, *Buchanania lanzan*, emblic (*Emblica officinalis*), tamarind (*Tamarindus indica*), serpentine wood (*Rauvolfia serpentine*)
	Kachchh Biosphere Reserve in Kutch district, Gujarat	Seepweed (*Suaeda* spp.), saltbush (*Atriplex* spp.), mamoncillo (*Aeluropus lagopoides*), *Sporobolus helvolus*, caper shrubs (*Capparis*), *Salvadora*, tamarisk (*Tamarix* spp.)
	Cold Desert Biosphere Reserve in Lahaul and Spiti district, Himachal Pradesh	*Elymus*, *Leymus*, *Hordeum*, *Hippophae salicifolia*, sea buckthorn (*Hippophae rhamnoides* ssp. *turkestanica*), *Tanacetum tibeticum*, caraway (*Carum carvi*), pepperweed (*Lepidium apetalum*), *Peganum harmala*, mountain sorrel (*Oxyris digyna*), *Sedum ewersii*, *Dianthus anatolicus*, *Sedum tibeticum*, *Aconitum violaecum*, *Picrorhiza kurrooa*, *Swertia petiolata*, *Rheum tibeticum*, *Podophyllum hexandrum*, *Cicer microphyllum*, yarrow (*Achillea millifolium*), *Thymus linearis*, oregano (*Origanum vulgare*)

Table 8 *Cont'd*

Country	National park/protected area	Target species for conservation
	Cold Desert Biosphere Reserve in Lahaul and Spiti district, Himachal Pradesh	*Elymus*, *Leymus*, *Hordeum*, *Hippophae salicifolia*, sea buckthorn (*Hippophae rhamnoides* ssp. *turkestanica*), *Tanacetum tibeticum*, caraway (*Carum carvi*), pepperweed (*Lepidium apetalum*), *Peganum harmala*, mountain sorrel (*Oxyris digyna*), *Sedum ewersii*, *Dianthus anatolicus*, *Sedum tibeticum*, *Aconitum violaecum*, *Picrorhiza kurrooa*, *Swertia petiolata*, *Rheum tibeticum*, *Podophyllum hexandrum*, *Cicer microphyllum*, yarrow (*Achillea millifolium*), *Thymus linearis*, oregano (*Origanum vulgare*)
	Panna Biosphere Reserve in Panna and Chhatarpur districts, Madhya Pradesh	*Chlorophytum tuberosum*, flame lily (*Gloriosa superba*), calamus (*Acorus calamus*), *Tinospora cordifolia*, Benghal prince (*Aegle marmelos*), Malabar kino (*Pterocarpus marsupium*), *Terminalia arjuna*, Asiatic pennywort (*Centella asiatica*), wild leadwort (*Plumbago zeylanica*), myrobalan (*Terminalia chebula*), *Madhuca indica*, miracle fruit (*Gymnema sylvestre*), withania (*Withania somnifera*), *adosa* (*Adathoda vasica*), *Andrographis paniculata*, Chinese chastetree (*Vitex negundo*), *Curculigo orchiodes*, *Aloe vera*, *Asparagus racemosus*, emblic (*Emblica officinalis*)
	Ganga River, Uttar Pradesh	Indian carp (*Catla catla*), rohu (*Labeo rohita*), mrigal carp (*Cirrhinus mrigala*)
	Dudhwa Sanctuary, Uttar Pradesh	Black rohu (*Labeo calbasu*), *Labeo dyocheilus*
	Samaspur Bird Sanctuary, Uttar Pradesh	*Labeo bata*
	Lonavala, Maharashtra	Black mahseer (*Tor khudree*), mahseer (*Tor tor*)
	Vembanad Lake, Kerala	Pearl spot (*Etroplus suratensis*), bulls eye catfish (*Horabagrus brachysoma*), *Labeo dyocheilus*, giant freshwater prawn (*Macrobrachium rosenbergii*)
Nepal	Lake Rara National Park	Unspecified endemic fish species
	Lake Phewa	Golden mahseer (*Tor putitora*)
Viet Nam	Ba Be National Park	Chinese incense-cedar (*Calocedrus macrolepis*), vang tam (*Manglietia conifera*)
	Ben En National Park	Chinese incense-cedar (*Calocedrus macrolepis*)
	Hoang Lien National Park	Fujian cypress (*Fokienia hodginsii*) and unspecified medicinal plants
	Pu Mat National Park	*Cunninghamia konishii*, Fujian cypress (*Fokienia hodginsii*)
	Earal and Trap Kso Protected Areas	Chinese swamp cypress (*Glyptostrobus pensilis*)
	York Don National Park	Dipterocarps (Dipterocarpaceae)
	Hon Mun Marine Protected Area in Nha Trang Bay	Unspecified marine genetic resources
	Cham Island Marine Protected Area	Unspecified marine genetic resources
	Phu Quoc Marine Protected Area	Unspecified marine genetic resources

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

many rare and endangered species, including species of relevance to food and agriculture. Illegal exploitation of plant and tree species with high economic value is, however, not uncommon in these areas and needs to be addressed. Similarly, Afghanistan reports that it has designated new sites as national parks/protected areas for the conservation of, *inter alia*, alpine vegetation, wild plant, fruit and nut varieties, and bird species. It notes that *in situ* conservation efforts of this kind have been constrained by political instability and social unrest.

Several countries mention the important contribution that national parks that include rivers and wetlands make to the protection and conservation of aquatic resources, and of endemic fish species in particular. At the same time, however, they mention that such areas could be managed more actively. India mentions that it has four major national marine parks, three marine sanctuaries and four biosphere reserves that contribute to the conservation of aquatic ecosystems. It notes, however, that coverage of aquatic biodiversity still lags behind that of terrestrial biodiversity. Some examples of actions taken to address specific drivers of change threatening BFA are presented in Box 5.

Box 5. Countermeasures taken to reduce adverse effects of drivers of change on associated biodiversity, ecosystem services and/or wild foods: examples from Bangladesh and China

Bangladesh has developed and is implementing community-based coastal and wetland biodiversity management and adaptation strategies to protect and maintain its Ecologically Critical Areas. The country also has several agri-environment schemes that contribute to reducing the adverse consequences of drivers on associated biodiversity and ecosystem services (Mustafa, Ilyas and Mahalder, 2014). Other mechanisms include:

- Projects are undertaken to promote integrated natural resource management in flood plain ecosystems to restore wetland habitats, increase aquatic biodiversity and improve fish productivity (Aziz *et al.*, 2014).
- Community-based forest management and the declaration of wildlife sanctuaries and other protected areas have positively affected biodiversity and habitats.
- Declaration of fish sanctuaries, where unauthorized fishing is prohibited, has contributed to the protection aquatic biodiversity.

China has strengthened its regulation system to promote the sustainable utilization and conservation of biological resources. It has put in place a biodiversity conservation network and introduced a range of special permits to limit hunting of wildlife species, collection of protected plants, and forest and fish harvesting. China also provides subsidies to farmer households that implement key ecological practices and that contribute to the country's Returning Farmland to Forest programme.

Sources: Adapted from the country reports of Bangladesh and China.

2.2.2 *Ex situ* conservation

All the country reports from the region include information on the status and trends of *ex situ* conservation efforts for genetic resources for food and agriculture, in particular for crops and livestock, and on challenges in this field. Several also include lists of species of associated biodiversity and wild foods preserved *ex situ*. A number of countries note that zoological gardens make an important contribution to *ex situ* conservation, particularly in the case of game species.

Viet Nam reports that it established its Biodiversity Conservation Agency to guide the implementation of conservation and sustainable development programmes and activities for biodiversity, including BFA. With regard to *ex situ* conservation specifically, activities include the maintenance of cryoconserved semen from several fish species including the common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idellus*), rohu (*Labeo rohit*a), mrigal carp (*Cirrhinus mrigala*), pangas catfish (*Pangasius hypophthalmus*), Javanese carp (*Barbodes gonionotus*), basa fish (*Pangasius bocourti*) and various marine species including groupers and cobia. The Viet Nam Type Culture Collection (VTCC), established in 1996, conserves approximately 9 000 strains of bacteria, fungi, yeast and streptomyces that are of high value to the food, medical and cosmetic industries.[8] Where edible mushrooms are concerned, a total of 124 accessions are conserved *ex situ*. The country report notes that while each of these strains has been evaluated for its growth and adaptation properties, little genetic characterization has been done.

Table 9 provides an overview of the countries in the region that reported on the status of the *ex situ* conservation of associated biodiversity and wild foods.

[8] http://imbt.vnu.edu.vn/en

Box 6. Conserving micro-organisms to improve agricultural production: an example from India

In 2001, the Government of India established the National Bureau of Agriculturally Important Micro-organisms to improve agricultural productivity by collecting, conserving and supplying agriculturally important micro-organisms (AIMs) across the country. The various species of AIMs conserved by the Bureau's National Agriculturally Important Microbial Culture Collection include approximately 850 bacteria and viruses, 7 175 algae (1 453 of which are cyanobacteria), 14 500 fungi and 2 223 lichens.

Like elsewhere in the world, micro-organisms play many essential roles in food and agriculture in India. They are, for example, vital to the decomposition and formation of soil organic matter, the uptake of plant nutrients, nitrogen fixation and the reduction of hazardous waste. They are used in numerous ways, including in (i) the production of biofertilizers, biopesticides and bioinoculants, (ii) crop biofortification, (iii) mitigation of abiotic stresses caused by nutrient deficiency, drought, salinity and extreme temperatures and (iv) food processing and (v) the production of antibiotics, vitamins, etc.

Needs and priorities in the conservation of AIMs in India include addressing the lack of baseline information on the diversity of micro-organisms in different ecosystems and agroecological zones, which makes it difficult to assess the impacts of management practices, climate change and natural disasters on microbial diversity. There is also a need to scale up the use of microbial diversity and microbe-based technologies and to improve their dissemination among farmers through extension networks. National policies facilitating the use of microbe-based technologies also need to be established.

Source: Adapted from the country report of India.

Table 9. Reported status of *ex situ* conservation of associated biodiversity and wild foods in Asia

Country	Category of biodiversity	Species/other taxonomic group(s)	Size of collection	Objective(s)
Bangladesh	Invertebrates	Bees	Partial characterization	Raised in artificial beehives and distributed for pollination and honey production
	Plants	Wild sugarcane (*Saccharum spontaneum*)	19 accessions, evaluation ongoing	Conservation
		Wild corchorus	282 accessions of 13 species	Conservation for future use
		Wild hibiscus	20 accessions	Conservation for future use
		Mangrove forest species	32 preservation plots	Conservation for study, research and future use
		Fodder crops and crops contributing to soil fertility	123 accessions	
	Micro-organisms	**Actinomycetes:** *Acrocarpospora* spp., *Actinokineospora diospyrosa*, *Actinomadura nitritigenes*, *Actinoplanes* spp., *A. arizonensis*, *A. aurantiacus*, *A. auranticolor*, *A. brasiliensis*, *A. campanulatus*, *A. capillaceus*, *A. deccanensis*, *A. ferrugineus*, *A. humidus*, *A. minutisporangius*, *A. philippinensis*, *A. regularis*, *A. sarveparensis*, *A. utahensis*, *Asanoa siamensis*, *Catellatospora bangladeshensis*, *Cellulomonas* spp., *Couchioplanes* spp., *Dactylosporangium aurantiacum*, *Herbidospora* spp., *Isoptericola* spp., *Kineococcus*-like, *Kineosporia aurantiaca*, *Kitasatospora putterlickiae*, *Krasilnikovia cinnamomea*, *Kribbella* spp., *Microbispora corallina*, *Microbispora rosea*, *Micromonospora carbonacea*, *Mycobacterium* spp., *Nocardia lijiangensis*, *Nonomuraea roseola*		Preserved in culture collections, used in applied microbiology and biotechnology, and for educational purposes

Table 9 *Cont'd*

Country	Category of biodiversity	Species/other taxonomic group(s)	Size of collection	Objective(s)
	Fungi	*Alternaria chartarum*, *Arthrinium phaeospermum*, *Aspergillus awamori*, *Beauveria bassiana*, *Blakeslea trispora*, *Ceratosporella lambdaseptata*, *Cercophora terricola*, *Circinella* spp., *Cladosporium*, *Cunninghamella* spp., *Curvularia lunata*, *Cylindrocladiella* spp., *Doratomyces stemonitis*, *Emericella nidulans*, *Eupenicillium ochrosalmoneum*, *Eurotium amstelodami*, *Fusarium oxysporum*, *F. proliferatum*, *Gongronella butleri*, *Graphium penicillioides*, *Humicola* spp., *Idriella lunata*		
	Yeast	*Ambrosiozyma platypodis*, *Ashbya gossypii*, *Asterotremella humicola*, *Athroascus javanensis*, *Aureobasidium* spp., *Bullera kunmingensis*, *Candida albicans*, *Clavispora lusitaniae*, *Eremothecium ashbyii*, *Cryptococcus dejecticola*, *Debaryomyces hansenii*, *Endomyces decipiens*, *Filobasidium capsuligenum*, *Geotrichum candidum*, *Hannaella luteola*, *Hanseniaspora thailandica*, *Hansenula anomala*, *Hyphopichia burtonii*, *Issatchenkia orientalis*, *Jaminaea angkorensis*		
	Edible mushrooms	White oyster mushroom *(Pleurotus florida)*, oyster mushroom *(P. ostreatus)*, king oyster mushroom *(P. eryngii)*, *P. sapidus*, branched oyster mushroom *(P. cornucopiae)*, feral oyster mushroom *(P. eryngii* var. *ferulae)*, blue oyster mushroom *(P. ostreatus var. columbinus)*, Indian oyster mushroom *(P. pulmonarious)*, *P. ferulae*, *P. sajocaju*, *P. geestezanus*, *P. cystidiosus*, *P. sajor*, *P. citrinopileatus*, *P. sdimoneo- straminine*, *Ganoderma lucidum*, *Agaricus bisporus*, *A. blazei*, *Lentinus edodes*, *Auricularia polytricha*, *A. auricular*, *A. judae*, *Volvariela volvacea*, *Flammulina velutipes*, *Stropharia rugosa*, *Pholiota nameko*, *Coprinus comatus*, *Tremella fuciformic*, *T. auratiabla*, *Clitocybe maxima*, *Agrocybe aegerita*, *Hypsizygus marmoreus*, *Pleurotus nebrodensis*, *Hericium erinaceus*, *Tricholoma lobayense*, *Dictyophora duplicate*, *Ganoderma* spp., *G. lucidum*, *Hypsizygus marmoreus*, *H. tessulatas*, *Tricholoma* spp., *Lentinula edodes*, *Trametes versicolor*		
	Bacteria	*Acinetobacter radioresistens*, *Aerococcus urinaeequi*, *Agrobacterium tumefaciens*, *Arthrobacter globiformis*, *Aureobacterium testaceum*, *Azospirillum brasilense*, *Bacillus mycoides*, *Bradyrhizobium japonicum*, *Brevibacillus brevis*, *Brevibacterium iodinum*, *Burkholderia stabilis*, *Cellulomonas flavigena*, *Citrobacter freundii*, *Cobetia marina*, *Comamonas*, *Corynebacterium crenatum*, *Curtobacterium citreum*, *Delftia lacustris*, *Enhydrobacter aerosaccus*, *Enterococcus faecalis*, *Halobacillus litoralis*		
India	Vertebrates (birds)	White-backed vulture (*Gyps bengalensis*), long-billed vulture (*G. indicus*), slender-billed vulture (*G. tenuirostris*)	Hundreds	To conserve different species of Indian vultures

Table 9 *Cont'd*

Country	Category of biodiversity	Species/other taxonomic group(s)	Size of collection	Objective(s)
	Vertebrates (fish)		Cryopreservation of milt:	Long-term conservation and breeding
		Rohu (*Labeo rohita*)	200	
		Indian carp (*Catla catla*)	200	
		Mrigal carp (*Cirrhinus mrigala*)	100	
		Labeo fimbriatus	50	
		Black rohu (*Labeo calbasu*)	50	
		Malabar labeo (*Labeo dussumieri*)	20	
		Labeo dyocheilus	20	
		Labeo dero	20	
		Hilsa herring (*Tenualosa ilisha*)	20	
		Ompok malabaricus	10	
		Common snow trout (*Shizothorax richardsonii*)	10	
		Golden mahseer (*Tor putitora*)	50	
		Black mahseer (*Tor khudree*)	20	
		Clarias magur	20	
		Stinging catfish (*Heteropneustes fossilis*)	10	
		Bulls eye catfish (*Horabagrus brachysoma*)	30	
	Invertebrates	Trichogramma wasps: *T. chilonis* *T. japonicum* *T. achaeae* *T. cacoceae* *T. embryophagum* *T. pretiosum* *T. brassicae* *Trichogrammatoidea bactrae* *Chrysoperla zastrowi sillemi* Mealy bug destroyer (*Cryptolaemus montrouzieri*)		Nucleus culture of eggs of rice meal moths (*Corcyra cephalonica*) Conservation of mealy bug destroyers (*Cryptolaemus montrouzieri*) under ambient conditions in laboratory for distribution as biological control agents to farmers, commercial producers and scientists
	Plants	*Prunus* spp., apricot (*P. armeniaca*), Himalayan bird cherry (*P. cornuta*), wild Himalayan cherry (*P. cerasoides*), clammy cherry (*Cordia obliqua*), *Ficus* spp., banyan (*F. benghalensis*), common fig (*F. carica*), hairy fig (*F. hispida*), Indian fig tree (*F. glomerate/F. racemose*), bo tree (*F. religiosa*), *Rubus* spp., lean raspberry (*R. macilentus*), Panama berry (*Muntingia calabura*), wild caper bush (*Capparis separia*), caper bush (*C. spinosa*), Surinam cherry (*Eugenia uniflora*), *Citrus* spp., calamondin (*C. madurensis*), pond apple (*Annona glabra*), custard apple (*A. reticulata*), sugar apple (*A. squamosa*), date palm (*Phoenix dactylifera*), dwarf fan palm (*P. humilis*), wild date palm (*P. sylvestris*), wild grape (*Vitis latifolia*), dhaman (*Grewia tiliaefolia*), Jacquemont's hazel (*Corylus jacquementii*), *Cordia dichotoma gürke*, *C. rothii*, Indian woodapple (*Limonia acidissima*), jackal jujube (*Ziziphus oenoplia*), black plum (*Syzygium cumini*), *S. stocksii*, *S. zeylanicum*, lac tree (*Schleichera oleosa*), *S. trijuga*,	105	

Table 9 *Cont'd*

Country	Category of biodiversity	Species/other taxonomic group(s)	Size of collection	Objective(s)
		Cordia spp., Assyrian plum (*C. myxa*), Indian olive (*Olea cuspidate*), European olive (*O. europaea*), *Passiflora* spp., black passionfruit (*P. edulis*), bush passionfruit (*P. foetida*), date plum (*Diospyros lotus*), pomegranate (*Punica granatum*), *Protium serratum*, Asian gooseberry (*Ribes alpestre*), *R. glaciale*, *Samadera indica*, *Fragaria* spp., *Trewia nudiflora*, walnut (*Juglans* spp.), *Dioscorea pubera*		
		Cenizo (*Chenopodium album*), nettle leaved fathen (*C. murale*)	123	
		Buckwheat (*Fagopyrum* spp.): common buckwheat (*F. esculentum*), tartary buckwheat (*F. tataricum*), *F. tataricum* ssp. *himalianum*, *F. tataricum* ssp. *emarginatum*	994	
		Sweet watermelon (*Citrullus vulgaris* var. *citroide*), colocynth (*C. colocynthis*)	146	
		Scarlet-fruited ivy gourd (*Coccinia grandes*)	34	
		Cuddapah almond (*Buchanania axillaris*), chironji (*B. lanzan*), chirauli nut (*B. latifolia*)	97	
		Karira (*Capparis decidus*)	23	
		Bakul (*Mimusops elengi*)	16	
		Christ's thorn (*Carissa carandas*), karanda (*C. congesta*), bush plum (*C. spinarum*), *C. spinosa*	14	
		Indian jujube (*Ziziphus mauritiana*), *Z. mauritiana* var. *fruticosa*, zuna berry (*Z. rugosa*), *Z. xylopyrus*	9	
		Moa tree (*Madhuca indica*), mahua (*M. longifolia*)	8	
		unspecified	1 584 species	Conservation for the long term and sustainable use
	Micro-organisms	*Bacillus thuringiensis, Beauveria bassiana, Metarhizium anisopliae, Heterorhabditis indica, Steinernema carpocapsae*		
	Macro fungi	*Agaricus* spp., *Lentinus squarrosulus*, *Hericium* spp., *Auricularia olivaceus*, *Volvariella volvacea*, *Calocybe indica*, *Helvella villosa*, *Entoloma* spp., *Flammulina* spp., *Cantharellus applanatus*, *C. elongatipes*, *Paneolus* spp., *Cystolepiota omerospora*, *Macrolepiota heimii*, *Isaria sinclairii*, *Psilocybe* spp., *Leucoagaricus* spp., *Schizostoma* spp., *Limacella* spp., *Amanita* spp., *Leucopaxillus* spp., *Cordyceps* spp.	1 000 accessions	Medium-term storage for utilization in food, medicine, nutrition, etc.
	Micro-organisms and fungi	Bacteria, archaea, actinomycetes, mushrooms and cyanobacteria	27 427 accessions in various institutes	Conservation of India's microbial wealth for utilization in agriculture and related sectors
Nepal	Plants	Indian wild rice (*Oryza nivara*), brownbeard rice (*O. rufipogan*)	3 accessions, not characterized	For distribution

Table 9 *Cont'd*

Country	Category of biodiversity	Species/other taxonomic group(s)	Size of collection	Objective(s)
Sri Lanka	Vertebrates (fish)	Mudfish (*Channa striata*)	1 200 – broodstock	
		Shark catfish (*Wallago attu*)	20 – broodstock	
		Butter catfish (*Ompok bimaculatus*)	75 – captive breeding	
		Black mahseer (*Tor khudree*)	10 – captive breeding	
		Malabar labeo (*Labeo dussumieri*)	1 000 – broodstock	
		Giant snakehead (*Channa ara*) *Puntius spilurus* Mountain labeo (*Labeo fisheri*) Climbing perch (*Anabas testudineus*) Long finned ell (*Anguilla nebulosa*) Stinging catfish (*Heteropneustes fossilis*) Walking catfish (*Clarias brachysoma*) Banded pearlspot (*Etroplus suratensis*)		
	Vertebrates (game species)	Wild boar (*Sus scrofa*) Spotted deer (*Axis axis*) Barking deer (*Muntiacus muntjak*) Mouse deer (*Tragulus* spp.) Porcupine (*Hystrix* spp.) Sambar (*Rusa unicolor*)		Conserved in zoological gardens for educational, conservation and recreational puposes
	Plants	Pasture and fodder crop species		Education
		Chlorella spp.		

Source: Calculated from FAOSTAT data for 2014.

2.2.3 Needs and priorities

Overall, the main challenges for *ex situ* conservation of associated biodiversity and wild foods are the lack of qualified human resources, funds and strategies or action plans that embed the conservation of these components of biodiversity. The absence of up-to-date data is reported as one of the main gaps in relation to both *in situ* and *ex situ* conservation of BFA. Although several national plans for the conservation of natural resources are mentioned in the country reports, these do not necessarily address wild foods.

Countries generally agree that an integrated approach that involves both *in situ* and *ex situ* methods is the best way to conserve BFA. Maintaining species *in situ* has the advantage of allowing ongoing adaptation to local conditions through natural selection, something that cannot be recreated *ex situ*. However, *ex situ* conservation can act as an "insurance policy" in that it preserves genetic resources that can potentially be reintroduced if *in situ* populations are lost. It also provides opportunities to study the conserved resources and hence potentially to improve conservation strategies. The country reports describe a number of cases in which conservation strategies for plant (crop), animal (livestock), forest and aquatic genetic resources involve combining *in situ* and *ex situ* activities. However, there are very few such examples for associated and/or wild food species. Some countries indicate that integrated approaches to conservation should be further explored.

There is general agreement among the reporting countries that breeding programmes are of great importance to the conservation and sustainable use of BFA. However, some mention that they are unable to operationalize breeding programmes because of a shortage of funding. Nepal mentions that a lack of national legislation, monitoring programmes, appropriate incentive mechanisms and linkages between formal institutions and communities is a serious constraint to the conservation of plant genetic resources, crop associated biodiversity and wild edible plants.

2.3 ACCESS AND EXCHANGE

Table 10 lists the main reported measures taken in the region to (i) regulate access to and (ii) ensure the fair and equitable sharing of benefits arising from the utilization of BFA.

Table 10. Reported measures regulating access and benefit-sharing for biodiversity for food and agriculture in Asia

Components of biodiversity for food and agriculture	Description of measures[1]	Countries
Genetic resources that are covered by the Convention on Biological Diversity (CBD) and related traditional knowledge[2]	The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (Nagoya Protocol) The Nagoya Protocol entered into force on 12 October 2014. It provides a legal framework for the effective implementation of the fair and equitable sharing of benefits arising out of the utilization of genetic resources.	Contracting Parties Afghanistan, Bhutan, Cambodia, China, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Viet Nam Signatories only Bangladesh, Thailand --- Bangladesh is willing to take measures to ensure that access to genetic resources becomes subject to prior informed consent (PIC). Implementing such measures would, however, require policies of relevance to the collection and conservation of biodiversity for food and agriculture, which are currently lacking. Nepal's Ministry of Forest and Soil Conservation drafted a bill on access to genetic resources and benefit-sharing. Once this bill has been enacted into law, access to, and sharing of benefits arising from the use of, biodiversity, and genetic resources in particular, will be easier to regulate. In 2008, Viet Nam adopted the Biodiversity Law with the objective, *inter alia*, of (i) ensuring the sustainable management of genetic resources, (ii) regulating access to genetic resources and the sharing of benefits derived from their utilization and (iii) protecting traditional knowledge associated with genetic resources. To enforce the Biodiversity Law, a wide range of secondary legislation still needs to be prepared for government approval, which is a very challenging task. Under the Biodiversity Law, a company that commercializes a new plant variety could be required to obtain permission from the Ministry of Agriculture and Rural Developments. It could also be requested to pay taxes. In the case of micro-organisms, invertebrates and wild and cultivated terrestrial and aquatic plants, if used for research and commercial purposes, both PIC and benefit-sharing are required. The same is true for invertebrates that are used for rearing and for wild and cultivated plants that are used for planting.
Plant genetic resources for food and agriculture	*International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)* Contracting Parties to the ITPGRFA make plant genetic resources for food and agriculture available within the framework of the Treaty's Multilateral System.[3] Parties wishing to provide and receive material under the Multilateral System use the Standard Material Transfer Agreement.[4]	Contracting Parties Afghanistan, Bangladesh, Bhutan, Cambodia, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka Signatory only Thailand --- Nepal's National Agrobiodiversity Policy takes into account the provisions of the ITPGRFA, including the Treaty's Multilateral System of Access and Benefit-sharing. PIC must be obtained for any form of use of crop diversity, be it for research and development or for commercial purposes; benefit-sharing only applies in the case of commercial use. The country's Biotechnology Policy, which does not take the Treaty's provisions into consideration, does underscore the role of research, development and transfer of agricultural biotechnology in the sustainable use of crop diversity.

Table 10 *Cont'd*

Components of biodiversity for food and agriculture	Description of measures[1]	Countries
Genetic resources and traditional knowledge belonging to indigenous peoples and local communities		Bangladesh reports having no measures in place for regulating access to or the utilization of genetic resources belonging to indigenous and local communities. It indicates that its Biodiversity Act could provide the framework needed to ensure that access to these genetic resources is subject to PIC. Nepal's National Agrobiodiversity Policy aims to promote conservation and sustainable use of genetic resources used in agriculture and their associated traditional knowledge, as well as the fair and equitable sharing of benefits arising from their use. A bill on access to genetic resources and benefit-sharing has been drafted to ensure that PIC is obtained for access to genetic resources that are held by indigenous and local communities, and that benefits are shared in a fair and equitable way with the communities concerned, based on mutually agreed terms. In 2008, Viet Nam adopted the Biodiversity Law, including to regulate access to genetic resources and associated traditional knowledge and ensure the sharing of benefits derived from their utilization. Overall, however, mechanisms to ensure the enactment of this law are still lacking. India's Biological Diversity Act of 2002 provides a framework for access to biological resources and associated knowledge, and the sharing of benefits derived from their use. The Biological Diversity Act and Rules (2004) include provisions regulating the access to, and sharing of benefits from the use of, indigenous fish species that are used for commercial purposes. China is developing policies, systems and information exchange mechanisms relevant to access to, and sharing of benefits from the use of, genetic resources and associated traditional knowledge.

[1] Measures facilitating access to the different components of biodiversity for food and agriculture usually vary according to the intended use of the resource (e.g. any use, research and development, commercial use). Examples of possible measures consist of the need to obtain prior informed consent, sharing benefits based on mutually agreed terms, having special considerations in place for access to resources held by indigenous peoples and local communities, etc.
[2] A number of countries reported not having any legally recognized indigenous communities.
[3] The Multilateral System of the ITPGRFA has put 64 crops (listed in Annex 1 to the Treaty) into an easily accessible global pool of genetic resources that is freely available to potential users in the Treaty's ratifying nations for research, breeding and training for food and agriculture. Those who access genetic materials through the Multilateral System agree to share any benefits from their use through the four benefit-sharing mechanisms established by the Treaty.
[4] The Standard Material Transfer Agreement is a private contract with standard terms and conditions that ensures that the relevant provisions of the ITPGRFA are followed by individual providers and recipients of plant genetic material.
Source: Websites of the CBD and ITPGRFA, and country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

While recognizing the need to regulate access to components of BFA and facilitate the fair and equitable sharing of benefits derived from their use, most countries indicate that they do not have the institutional frameworks, capacity and knowledge needed to develop and implement appropriate legislation. The diverse, and often conflicting, interests of different stakeholder groups, as well as limited understanding of the value of biodiversity to food security, climate change adaptation and economic stability, are also reported to hinder the development of laws and policies. There seems to be general agreement among the reporting countries that additional guidance is needed on access and benefit-sharing, in particular with respect to the implementation of the Nagoya Protocol, especially at the institutional level.

Nepal reports that an increase in external disaster-relief interventions and assistance (e.g. following earthquakes and landslides) has been accompanied by an increase in biopiracy and mentions that it has no policy or legal measures in place to control the problem. It mentions, citing Upreti and Upreti (1999), that buckwheat (*Bhate phapar*), balsam-pear (*Momordica charantia*) and wild-rice germplasm has been taken to other countries without legal arrangements under such circumstances. India reports the need for legislation similar to its Protection of Plant Variety and Farmers Right Act to address animal breeds and livestock keepers' rights.

III. Policies, institutions and capacity

3.1 POLICIES, PROGRAMMES, INSTITUTIONS AND STAKEHOLDERS

3.1.1 Policies and programmes

A large number of policies and programmes with a direct or indirect impact on the conservation and use of BFA are reported to be implemented in the region.

Most reporting countries have national policies and programmes and legal and operational frameworks in place for the conservation and sustainable use of animal, plant, forest and aquatic genetic resources. In most countries, these genetic resources are addressed in instruments such as forest acts, seed acts, fish acts and river protection acts.

With respect to national policies and programmes for the conservation and (to a lesser extent) use of associated biodiversity and wild food species, most countries refer to the importance of their respective national biodiversity strategy and action plans (NBSAP).[9] For example, as part of its NBSAP, China integrated biodiversity into local economic and social development plans through the establishment of more than 1 750 ecological towns and villages.

Other relevant national policies and programmes mentioned include the following: agro-environmental schemes and rural development programmes; forest, water and environmental policies and strategies contributing, *inter alia*, to the conservation of habitats and biodiversity; policies for the maintenance of wetlands and their integration into natural resource management and economic development; policies and management plans facilitating the implementation of ecosystem approaches (e.g. Bangladesh's coastal zone policies that promote the conservation of coastal ecosystems and their biodiversity and Viet Nam's Can Gio Mangrove Biosphere Reserve's management plan); buffer zone management regulations that contribute to the conservation of plant genetic resources and wild relatives (e.g. in Nepal); programmes to prevent the introduction

Box 7. Stakeholder engagement for the management of biodiversity for food and agriculture and ecosystem services in the light of climate change: an example from Bangladesh

The Policy Research for Development Alternative (UBINIG) is a community-led and community-based, policy and action-research organization. It was established in 1984 to support initiatives in which people take control of their lives and livelihoods. UBINIG started as a study circle searching for ways to ensure that development policies became more oriented to people's needs, particularly to the needs of poor and marginal populations. It collaborates with farmers, weavers, fisherfolk, artisans and crafts people, community health providers, rural entrepreneurs and rural communities.

Preserving the environment and addressing the impacts caused by environmental degradation are crucial to UBINIG's work. UBINIG also works closely to conserve Bangladesh's forests and to improve the lives and livelihoods of the indigenous communities that heavily rely on them.

Among its activities related to climate change, UBINIG promotes knowledge systems and practices that help to:

- mitigate river bank erosion;
- support the selection of appropriate seeds for specific agro-ecological zones; and
- conserve mangroves in coastal areas.

Source: Adapted from the country report of Bangladesh.

[9] Countries in Asia with NBSAPs as of December 2019: Afghanistan, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Timor-Leste, Viet Nam.

of, control or eradicate invasive alien species; policies promoting integrated pest management and biological control; and climate change policies, strategies and action plans, such as national adaptation programmes of action (NAPAs), energy-saving and emission-reducing schemes and a range of legal measures.

Countries also note the relevance of several specific legal instruments in this context, including biological diversity acts, environment conservation and protection acts (e.g. seven areas have been defined as ecologically critical under a such an act in Bangladesh), acts related to local and indigenous communities or forest dwellers (e.g. India has an act specifically recognizing the rights of forest communities); soil and water conservation acts; and wildlife acts providing a legal framework for the conservation and management of wildlife.

The country report from India highlights the establishment of its National Green Tribunal, a dedicated statutory environmental court dealing with civil cases related to the environment, including biodiversity. It also notes that jurisprudence on biodiversity continues to evolve.

A number of countries mention having national disaster management plans in place and note that they are highly relevant to the conservation and use of BFA (see Table 11). Some countries mention the importance of the support they receive in natural disaster situations from the South Asian Association for Regional Cooperation. Similarly, a number of countries report climate change policies, programmes and frameworks that embed the use of BFA (see Table 12).

Table 11. Disaster management and response policies, programmes and enabling frameworks in Asia reported to embed the use of biodiversity for food and agriculture

Country	Policies, programmes and frameworks
Bangladesh	National level • National Plan for Disaster Management (2016–2020) • Disaster Management Act: an act that outlines the obligations and responsibilities in the country's disaster management system and ensures transparency and accountability • Disaster Management and Information Centre's flood-risk and storm- surge inundation mapping programme (Sub)regional/international level • As a member state of the regional intergovernmental organization South Asian Association for Regional Cooperation (SAARC), the country: - established the Bangladesh Disaster Knowledge Network within the framework of the South Asian Disaster Knowledge Network – this network contributes to the exchange of information on disaster risk reduction, mitigation, response, preparedness and recovery in the South Asia subregion; and - contributed to the development of SAARC's Comprehensive Framework on Disaster Management, a platform for South Asian countries to strengthen the regional disaster management system. • The country is a member of the Asian Disaster Preparedness Centre, the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia, the Asian Ministerial Conference on Disaster Risk Reduction and the International Search and Rescue Advisory Group. • *Guidelines for climate proofing investment in agriculture, rural development, and food security* (ADB, 2012).
China	• National policies related to forest disaster management and response: - Forest Fire Prevention Ordinance - Middle- and Long-term Forest Fire Prevention Development Plan - Responsibility system at village-level • National policies for pest prevention and control • A "two-line" responsibility management system is in place for forestry pest emergency situations, for example in the case of outbreaks of pine wilt disease or of the fall webworm (*Hyphantria cunea*).
Viet Nam	• National Strategy for Natural Disaster Prevention, Response and Mitigation (2007–2020) • Law on Forest Protection and Development (2004). This law includes provisions that protect forests to ensure they can continue to fulfil their multiple roles (e.g. help secure safe and clean water, prevent erosion and desertification, avert or reduce the impact of natural disasters and regulate climate). • Ordinance on Prevention and Control of Floods and Storms (1993). This ordinance includes provisions related to activities conducted for the prevention, control and mitigation of the consequences of floods and storms.

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

Table 12. Climate change adaptation and mitigation policies, programmes and enabling frameworks in Asia reported to embed the use of biodiversity for food and agriculture

Country	Policies, programmes and frameworks
Bangladesh	• Bangladesh Climate Change Trust Fund, established in 2010, has the main objective of supporting the implementation of the Bangladesh Climate Change Strategy and Action Plan (CCSAP). The six main pillars of the CCSAP are: (i) food security, social safety and health; (ii) comprehensive disaster management; (iii) development of climate-proof infrastructure; (iv) research and knowledge management; (v) mitigation and low-carbon development; and (vi) capacity building. The fund's programmes and projects are financed by the national budget. • Bangladesh Climate Change Resilience Fund is a multidonor trust fund established in 2011 to facilitate the implementation of the Bangladesh Climate Change Strategy and Action Plan. Projects involving various ministries and international organizations have been developed and implemented under the umbrella of this fund, including establishment of multipurpose cyclone shelters, agricultural adaptation in climate risk-prone areas, promotion of community climate change initiatives and establishment of climate-resilient participatory afforestation and reforestation projects. • The Forest Department has taken a number of initiatives to address global warming. Several of its projects are undertaken under the Climate Change Trust Fund, while its Climate Resilient Participatory Afforestation and Reforestation project is being implemented under the Bangladesh Climate Change Resilient Fund.
China	• White Paper on Climate Change Mitigation Policies and Actions of the Forestry Sector (SFA, 2013). Objectives outlined in the White Paper include reducing forestry emissions, improving the adaptive capacity of forests and developing adaption management plans.
India	• National Innovations on Climate Resilient Agriculture. This network project was launched in 2011 by the Indian Council of Agricultural Research to enhance the resilience of India's agriculture to climate change and climate vulnerability through research and technology.
Nepal	• In some districts, the country has begun to launch awareness-raising programmes on adaptation to, and mitigation of, climate change. Following studies it conducted, Nepal's Agricultural Research Council has made some recommendations with respect to possible mitigation measures, but these are yet to be implemented.
Viet Nam	• National Target Program to Respond to Climate Change (2008). This initiative aims to integrate responses to climate change into the development of strategies, programmes and plans across all sectors and at all levels, as well as into legal and policy documents. Some of the targeted programmes focus on issues of relevance to the conservation and sustainable use of biodiversity for food and agriculture, such as the sustainable use of natural resources, natural disaster prevention, marine research, securing water supplies and forest protection. In terms of climate change mitigation: - The government supports several programmes that aim to maintain and enhance resilient forest carbon sinks and reduce greenhouse gas emissions. These include forest protection and conservation, as well as forest plantation programmes. - The Ministry of Agriculture and Rural Development, in collaboration with other ministries and relevant stakeholders, is developing a sectoral action plan, including policies, technologies and awareness-raising activities, to mitigate greenhouse-gas emissions, such as though the protection of forest carbon sinks.

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

3.1.2 Interministerial cooperation

Most Contracting Parties to the CBD, including those from the Asia region, have national strategies and enabling frameworks in place to implement the Strategic Plan for Biodiversity 2011–2020 and achieve the Aichi Biodiversity Targets. In most cases, these strategies were developed through a collaborative process, involving all relevant ministries, various civic groups and other interested parties. These stakeholders then continue to cooperate in national-level implementation activities and in reporting to the CBD on progress made.

Overall, interministerial cooperation specifically targeting the management of BFA seems to be very limited to non-existent in the region. Countries report that, even where national programmes and policies that are relevant to all sectors of food and agriculture are in place, these are not being implemented through cross-sectoral collaboration. India reports that it would rather harmonize policies and actions between sectors before promoting intersectoral cooperation. China and India both indicate that they have several *in situ* conservation initiatives in place for biodiversity that would benefit from cross-sectoral cooperation. However, they did not provide any details as to what needs to be done to bring this about.

3.2 CAPACITY AND RESEARCH NEEDS

Across the region, universities and other educational institutions have incorporated conservation and sustainable use of associated biodiversity into their curricula. Courses are, for example, offered on agroecology, soil fertility and soil management, forest ecology, marine ecology and

general biodiversity. The country report from China includes a list of more than 100 relevant courses spanning a range of topics. At the same time, some countries report that, in most education and research programmes, issues related to the conservation of biodiversity are addressed separately from those related to its sustainable use. As a result of this "decoupling", trained experts tend to lack skills in interdisciplinary work.

Nepal reports that the academic courses on forest genetic resources need to be updated so as to provide the skills needed to implement conservation programmes and also need to better address cross-cutting issues. India reports that it considers farmer training to be a priority and has developed several projects to improve work in this field. It notes that specific priorities in this context include the following: grassroots capacity-building programmes for the management of BFA to improve livelihood security; capacity development to improve post-harvest management; and marketing support for agriculture and fisheries, through the formation of self-help groups and farmer/community-based organizations such as agricultural cooperatives.

Several country reports indicate that associated biodiversity needs to be mainstreamed into national policies, research programmes and other activities in the food and agriculture sector. They note that this will first and foremost require awareness-raising on the roles and functions of associated biodiversity in production systems among decision-makers, farmers, local communities and the broader public.

Several countries report that research institutions should be given a mandate to study interrelationships between the various organisms present in and around production systems at various scales. Strengthening knowledge in this field is considered a priority for the development and implementation of adequate policies and programmes and of appropriate farm-level practices. A number of countries mention that farmers applying sustainable farming practices should be entitled to subsidies. Others mention that studies should be undertaken to explore new market opportunities and post-harvest technologies. Countries also reported that the linkages between associated biodiversity, food production and nutrition are still not well understood. They note that farmers need to be made aware of any progress made in this regard.

Overall, even if knowledge on associated biodiversity (particularly in soils) and ecosystem functioning is still limited across the region, countries are increasingly aware of the importance of strengthening research in this field. Given the various resource constraints countries face, they will need efficient strategies for prioritizing and implementing their research activities. A number of country reports indicate that coordination among research, extension and education in the field of BFA is very weak. Several countries note the need for relevant institutions to establish joint strategies to support research and monitoring. China refers to the need for national biodiversity surveys to gather baseline data, mentioning that these data would be used to build a national biodiversity monitoring and early warning system and establish national biodiversity assessments.

With many communities across the region highly dependent on wild foods for their food security and livelihoods, several countries report that research on wild food resources needs to be strengthened. Knowledge on edible wild food species, as well as technical and scientific research on the conservation and sustainable use of key and often vulnerable wild food species (e.g. water chestnut, wild plants in wetlands, etc.) needs to be improved.

Nepal mentions that more research could be undertaken on the positive effects of livestock production systems on the delivery of supporting ecosystem services, such as nutrient cycling. Some countries consider research on the conservation and sustainable use of aquatic biodiversity a priority. Viet Nam mentions that additional efforts need to be made to strengthen research on the introduction and the possible ecological and economic impacts of invasive alien species. A few countries mention the need to develop action plans and research and development programmes to facilitate and promote the adoption and implementation of ecosystem approaches and sustainable management practices.

IV. Regional and international cooperation

4.1 MAJOR REGIONAL INITIATIVES TO CONSERVE AND USE BIODIVERSITY FOR FOOD AND AGRICULTURE

Regional policies and programmes embedding the conservation and/or use of biodiversity for food and agriculture, and in particular of associated biodiversity, wild food species and ecosystem services, are described in Table 13.

Table 13. Reported regional and international initiatives addressing the conservation and/or use of biodiversity for food and agriculture in Asia

Policy or programme	Description	Countries involved
Regional programmes, institutions and associations		
Asia Pacific Association of Forest Research Institutions (APAFRI)	APAFRI aims to enhance research and technology-development capabilities in support of conservation and management of forest resources in the Asia-Pacific region.	Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand, Viet Nam
Asia Pacific Forest Genetic Resource Program (APFORGEN)	APFORGEN is a programme for the conservation and sustainable use of tropical forest genetic resources in the Asia-Pacific region.	Bangladesh, Cambodia, China, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Viet Nam
UNDP/FAO Regional Project on Improved Productivity of Man-Made Forests through Application of Technological Advances in Tree Breeding and Propagation (FORTIP)	This project aims to improve forest productivity through genetic enhancement of forest trees.	Bangladesh, Bhutan, India, Indonesia, Malaysia, Pakistan, Nepal, Philippines, Sri Lanka, Thailand
International Centre for Integrated Mountain Development (ICIMOD)	ICIMOD is a regional intergovernmental learning and knowledge-sharing centre serving the eight regional member countries of the Hindu Kush Himalaya	Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, Pakistan
South Asian Association for Regional Cooperation (SAARC) Forestry Center	SAARC aims to promote the welfare of the peoples of South Asia and to improve their quality of life. In this context, issues related to forest and environment conservation are dealt with by the association's Forestry Center.	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
International conventions, networks and treaties		
Convention on Biological Diversity (CBD)	The CBD aims to support countries to conserve their biological diversity, promote the sustainable use of its components and encourage equitable sharing of the benefits arising from its use.	Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Timor-Leste, Viet Nam
Convention Concerning the Protection of the World Cultural and Natural Heritage	The Convention aims at the identification, protection, conservation, presentation and transmission to future generations of cultural and natural heritage of Outstanding Universal Value.	Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Viet Nam
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Viet Nam

Table 13 *Cont'd*

Policy or programme	Description	Countries involved
Convention on Wetlands of International Importance (Ramsar Convention)	The Ramsar Convention is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources.	Bhutan, Bangladesh, Cambodia, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka, Thailand, Viet Nam
International Plant Protection Convention (IPPC)	The IPPC is a multilateral treaty that aims to secure coordinated, effective action to prevent and to control the introduction and spread of pests of plants and plant products. The Convention extends beyond the protection of cultivated plants to the protection of natural flora and plant products. It also takes into consideration both direct and indirect damage by pests, so it includes weeds.	Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Singapore, Sri Lanka, Thailand, Timor-Leste, Viet Nam
Bioversity International	Bioversity International is a global research-for-development organization. It delivers scientific evidence, management practices and policy options to use and safeguard agricultural and tree biodiversity to attain sustainable global food and nutrition security.	Bangladesh, Cambodia, China, India, Indonesia, Lao People's Democratic Republic, Nepal, Philippines, Sri Lanka, Viet Nam
International Network on Bamboo and Rattan (INBAR)	INBAR is a multilateral development organization that promotes environmentally sustainable development using bamboo and rattan.	Bangladesh, Bhutan, China, India, Indonesia, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Viet Nam
International Neem Network (INN)	INN aims to improve the genetic quality and adaptability of the neem tree to prevailing conditions and promote its utilization throughout the world.	Bangladesh, China, India, Lao People's Democratic Republic, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Viet Nam
International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)	The objectives of the ITPGRFA are the conservation and sustainable use of all plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising out of their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security.	Afghanistan, Bangladesh, Bhutan, Cambodia, Democratic People's Republic of Korea, India, Indonesia, Japan, Lao People's Democratic Republic, Malaysia, Maldives, Mongolia, Myanmar, Nepal, Pakistan, Philippines, Republic of Korea, Sri Lanka
Koshi Basin Initiative (KBI)	KBI aims to enhance the regionally coordinated management of the Koshi Basin for the improved wellbeing of local communities and sustainable use of ecosystem goods and services.	China, India, Nepal

Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019) and websites of the respective organizations, instruments and initiatives.

4.2 NEEDS AND PRIORITIES

Generally speaking, regional collaboration in relation to the management of associated biodiversity is very limited and fragmented. Several countries mention that it needs to be strengthened. The country report from Nepal mentions the need to strengthen collaboration at local, national, regional and international levels to improve the use of BFA in disaster response mechanisms. In this context, it particularly stresses the importance of sharing information and enhancing capacity building. It also notes that in order to better respond to the loss of genetic resources for food and agriculture there is a need for national, regional and global collaborative projects promoting bioprospecting.

Worldwide, invasive alien species are considered to be the second most important threat to biodiversity, behind land-use change. Given that they are of international concern, there might be a need to develop a regional and/or international methodology to assess the environmental impacts of alien species. Viet Nam proposes establishing invasive alien species National Focal Points to coordinate invasive alien species-related activities at regional and international levels, including sharing of scientific research results on species ecology and on methods of control and eradication. It also mentions the potential usefulness of establishing a regional multilingual IAS database linking all relevant national databases.

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The Asia Regional Synthesis for *The State of the World's Biodiversity for Food and Agriculture* summarizes the state of biodiversity for food and agriculture in the region, based largely on information provided in eight country reports submitted to FAO as part of the reporting process for the report on *The State of the World's Biodiversity for Food and Agriculture*.

Biodiversity for food and agriculture is the diversity of plants, animals and micro-organisms at genetic, species and ecosystem levels, present in and around crop, livestock, forest and aquatic production systems. It is essential to the structure, functions and processes of these systems, to livelihoods and food security, and to the supply of a wide range of ecosystem services. It has been managed or influenced by farmers, livestock keepers, forest dwellers, fish farmers and fisherfolk for hundreds of generations.

The report was originally prepared as supporting documentation for an informal regional consultation on the state of Asia's biodiversity for food and agriculture, held in Bangkok, Thailand, in April 2016. It was later revised based on feedback received from the participants of the informal consultation. It provides a description of the drivers of change affecting the region's biodiversity for food and agriculture and of its current status and trends. It also discusses the state of efforts to promote the sustainable use and conservation of biodiversity for food and agriculture in the region, including through the development of supporting policies, legal frameworks, institutions and capacities.

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