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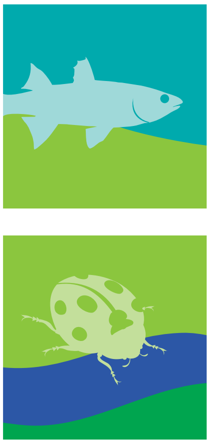

LATIN AMERICA AND THE CARIBBEAN REGIONAL SYNTHESIS FOR

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

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Foreword

This regional synthesis report highlights the many ways in which biodiversity is vital to food and agriculture in Latin America and the Caribbean, particularly given the need for region's production systems to adapt to a rapidly changing world, including to the effects of climate change. It also highlights the many threats facing the region's biodiversity, many of which are associated with effects of land-use change within the food and agriculture sector itself. On the more encouraging side, it notes the increased use, in some countries and production systems, of various potentially biodiversity-friendly management practices and approaches. It also describes a range of policies, programmes and projects that aim to conserve and sustainably use biodiversity for food and agriculture, including some specifically aimed at enhancing its role in the supply of important regulating and supporting ecosystem services.

The objective of the report, however, is not merely to outline the status of the region's biodiversity for food and agriculture and its management, but also to contribute to the identification of ways forward in terms of promoting its sustainable use and conservation. To this end, it provides a summary of the main needs and priorities identified in the country reports submitted as contributions to the preparation process for *The State of the World's Biodiversity for Food and Agricultur*e, published earlier this year, and at the informal regional workshop held in Panama City in 2016. These converge with the conclusions and recommendations of the High Level Regional Dialogue on Biodiversity and the Agricultural Sector (DRANIBA) held in Mexico City in 2018.

It is clear, for example, that management initiatives are often constrained by gaps in knowledge and by ineffective institutional frameworks. It is also clear, however, that we need more than just individual projects aimed at conserving or utilizing specific components of biodiversity. It is time for a concerted effort to address the drivers of change that are contributing to the loss of biodiversity and to build a more sustainable food and agriculture sector. This will require action not only at national level, but also globally and regionally. The report draws attention to many of the benefits that can flow from regional initiatives in the field of biodiversity management – from technology transfer to avoiding duplication of work. While there are examples of success, much more could be done to promote this kind of collaboration.

To conclude on a positive note, it is very heartening that so many of the region's countries engaged in the process that led to the preparation of this document and remain engaged in efforts to identify opportunities to promote the sustainable management of biodiversity for food and agriculture.

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About this report

BACKGROUND

This report summarizes the state of biodiversity for food and agriculture (BFA) in Latin America and the Caribbean 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 was prepared as supporting documentation for an informal regional consultation on the state of Latin America and the Caribbean's biodiversity for food and agriculture held in Panama City, Panama, 8 to 10 March 2016. The document was later revised based on feedback received from the participants of the informal consultation and on additional country reports and country-report updates received by FAO before September 2016. The final report is based on 13 country reports. During the informal consultation, participants also discussed regional needs, priorities and possible actions for the conservation and sustainable use of biodiversity for food and agriculture.[1]

SCOPE

The report addresses the biodiversity for food and agriculture (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

Biodiversity for food and agriculture 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. Biodiversity for food and agriculture also encompasses 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;

[1] See Annex 2 of the Report of the Informal Regional Consultation on the State of Latin America's and the Caribbean's Biodiversity for Food and Agriculture (CGRFA-16/17/Inf.11.4) (FAO, 2016).

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;
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 Latin America and the Caribbean 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 Latin America and the Caribbean's biodiversity for food and agriculture held in Panama City, Panama, 8 to 10 March 2016.

SUMMARY

This report summarizes the state of knowledge on biodiversity for food and agriculture (BFA) in the Latin America and the Caribbean (LAC) region as a contribution to the global report on *The State of the World's 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 agriculture products and services. Production systems, as defined in this report include the livestock, crop, fisheries and aquaculture and forest sectors.

Agriculture needs to break its increasing dependence on non-renewable resources (FAO and PAR, 2011), and signs that policy is shifting in this direction are increasingly evident in the LAC region. Public policies for the promotion of agroecology and other forms of biodiversity-rich agriculture are in place or under development at national, district or municipal levels in several countries. At the same time, the region is experiencing significant demographic, market and land-use changes and has an increasingly urban population that is placing growing demands on agriculture and rural areas.

The countries that contributed to this report are the Bahamas, Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia and Suriname. These countries represent about 21 percent of the region's total area of agricultural land, forest and water. The following paragraphs present major highlights from the four main sections of the report.

Assessment and monitoring of biodiversity for food and agriculture

Most reporting countries indicated that a lack of information, data or monitoring systems, along with insufficient knowledge or research, is limiting their ability to map production systems and BFA.

Most countries indicated that they have difficulties reporting on associated biodiversity and the ecosystem services they provide. Countries reported that a number of species of associated biodiversity are being actively managed to promote the supply of ecosystem services: most commonly for soil formation and protection services, pollination, habitat provisioning, regulation of pests and diseases and atmospheric regulation. Fewer species were reported to be actively managed for water purification and waste treatment or for nutrient cycling.

The most frequently reported species of wild foods were terrestrial mammals, followed by terrestrial plants and freshwater fish. Countries indicated that there is not enough information to provide proper assessments and proposed that more support should be given to ethnobotanical research.

The country reports differed in terms of the level of detail with which the various trends and drivers of change affecting associated biodiversity, ecosystem services and wild food resources were reported. The most commonly mentioned drivers included:

- replacement of local production systems and genetic resources;
- emergence of new weeds, pests and diseases;
- adverse climatic factors (frost, droughts, floods);
- uncontrolled fire;
- overgrazing and overexploitation of wild species;
- urbanization and population pressure;
- migration;
- inadequate policies and legislation;
- inequity and other social problems; and
- hunger and poverty.

In terms of needs and priorities, countries that do not have an inventory of BFA or do not have monitoring systems in place highlighted the need to address these gaps.

Sustainable use and conservation of biodiversity for food and agriculture

The country reports indicate that at regional level there is a generalized decline in the implementation of integrated pest and nutrient management and an increase in diversity-based strategies such as domestication of wild species and the use of native tree diversity in the maintenance or conservation of landscape complexity.

As incomes rise, the region is undergoing a rapid transition towards a so-called "western" diet, dominated by refined sugars and carbohydrates, refined fats, oils and meat. This has negative consequences for BFA.

In many parts of the region, the supply of energy depends almost entirely on associated plant biodiversity, particularly in places where rural populations do not have access to electricity or gas for their domestic needs.

Most of the plans and initiatives reported in the country reports as addressing the use of BFA to cope with climate change, invasive alien species and natural or human-made disasters do not show very specifically how BFA is contributing to efforts to tackle these problems.

Several countries reported on the use of ecosystem, landscape and seascape approaches for the conservation of biodiversity in general and BFA in particular, especially in marine and forest ecosystems.

All countries reported *in situ* and *ex situ* conservation efforts. The list of associated biodiversity and wild foods species reported to be conserved *ex situ* comprised 25 plant species, 16 terrestrial vertebrate species, 10 fungi species (including 8 mycorrhizas), 10 species of bacteria, 8 aquatic vertebrate species and 8 invertebrate species.

Most countries mentioned research and knowledge gaps with respect to traditional forms of sustainable use of biodiversity, noting in this regard the need for capacity development and for improved material and human resources, institutional capacities, innovation and dissemination of knowledge to policy-makers and decision-makers.

Several countries indicated the need to consolidate BFA-related policies and actions, responsibility for which is now typically spread over several ministries within a given country (agriculture, environment, culture, natural resources, fisheries, development, etc.), creating institutional islands, miscommunication and competition.

The need for better information about illegal practices (e.g. in the case of fishing activities) and their impact on biodiversity conservation was also highlighted.

There were also calls for better integration of biodiversity conservation and agricultural agendas.

Several countries proposed that support for the diffusion of agroecological approaches should be a priority in this regard.

Several countries reported that prior informed consent is a prerequisite for access to BFA, both genetic resources for food and agriculture and associated biodiversity and wild foods. However, most countries indicated the need to develop norms and policies on access, exchange and benefit-sharing and to train personnel in the implementation of legal mechanisms in this field.

Policies, institutions and capacities

Strictly speaking, most of the policies and programmes reported by countries are not policies but national laws that regulate, mandate and guide the development of relevant policies.

Countries also reported laws that are under development or that have been approved but not yet promulgated or implemented. Several of these address the need to align national policies with international agreements such as the Nagoya Protocol.

Most countries reported food security policies and programmes, but did not explicitly indicate how these instruments are linked to BFA. In some cases, different strategies or programmes within a country have conflicting objectives.

Most countries also reported a lack of connectedness and collaboration between ministries or a lack of clarity regarding responsibilities for BFA management.

Countries that do not have policies and regulations on BFA in place indicated that developing and implementing instruments of this kind is a priority. Countries that have such instruments indicated that promoting greater interinstitutional (interministerial) coordination is the main priority.

The main priorities in terms of training, education and capacity development can be summarized as follows:

- establishment of higher-education programmes that focus on, or include, BFA and its management;
- capacity development for professionals on technical and legal matters and for field technicians on biodiversity management and conservation;
- training for farmers on aspects of sustainable use and management, particularly of associated biodiversity; and
- training of communicators who can raise awareness among the general public.

Several countries reported research needs related to micro-organisms, their conservation and their management for agricultural (crop and livestock) and forest production. Inventory and characterization of genetic resources and associated biodiversity were also repeatedly mentioned, as was research on wild pollinators and on indigenous management of BFA.

Regional and international cooperation

The regional initiatives reported (e.g. the Mesoamerica Network on Genetic Resources) have the following objectives:

- technology transfer;
- increasing the participation of stakeholders;
- improving access to financial resources through participation;
- improving research facilities;
- exchanging expertise;
- training scientists from national programmes;
- exchanging information;
- providing access to advanced research results;
- characterization and evaluation of germplasm;
- increasing public awareness of plant genetic resources for food and agriculture; and
- avoiding duplication of activities.

Several of the transnational/regional initiatives reported were not explicitly concerned with BFA. Conversely, not all relevant regional programmes were necessarily mentioned in the country reports (e.g. the Latin American Forest Genetic Resources Network [LAFORGEN], the Andean and Amazonian Plant Genetic Resources Network [REDARFIT, TROPIGEN] and the Regional Global Environment Facility project Strengthening the Implementation of Regimes of Access to Genetic Resources and Benefit Sharing in Latin America and the Caribbean).

General introduction

Delivering safe and nutritious food for a growing, increasingly affluent, but socio-economically unequal, world population poses serious challenges to future plant, forest, aquatic and animal production. Prominent among these challenges is the need to increase global production while preserving the ability of landscapes and seascapes to deliver other ecosystem services that are essential for life on Earth, now and in the future. In spite of repeated warnings about the rapid loss of biodiversity for food and agriculture (BFA) (FAO and PAR 2011) and the mounting evidence about the key role of biodiversity in food security and nutrition (e.g. Kawarazuka and Béné, 2011; Powell, 2012; Pinstrup-Andersen, 2013), agricultural systems worldwide are becoming ever simpler, more structurally uniform and more oligospecific (e.g. Foley *et al.*, 2005; Grau *et al.,* 2005; Fischer *et al.*, 2007; Kleijn *et al.*, 2009; Geiger *et al.*, 2010; Godfray *et al.*, 2010; Tilman *et al.,* 2011; Barnosky *et al.*, 2011; Kremen and Miles, 2012; Tscharntke *et al.*, 2012; Cunningham *et al.*, 2013; Puma *et al.*, 2015; MacFadyen *et al.,* 2016). Today, a few crop and animal species account for most of the food consumed by humans worldwide (Khoury *et al.*, 2014). This trend has serious implications for (i) human nutrition and diet-related risks, (ii) biodiversity and associated ecosystem services and (iii) the resilience of agricultural systems and their adaptability to global change.

Biodiversity offers promising opportunities to design innovative production systems that contribute to the four pillars of food security by enhancing the efficiency of biological processes in agroecosystems. In addition to being a "global theatre for biodiversity" in general (ICSU-LAC, 2010), the Latin America and the Caribbean region also hosts the widest genetic resource base for some of the crop species most commonly cultivated and consumed worldwide, including maize, potatoes, cassava, sweet potatoes, tomatoes, beans, peanuts and pumpkins. The number of wild food, non-traditional and underutilized edible plant and animal species is also vast (e.g. Peñafiel *et al.*, 2011). The region has vast areas of biodiverse and resilient native grasslands and rangelands that are able to maintain large and diverse livestock populations (including endemic camelids) year round, as well as wild biodiversity (Modernel *et al.*, 2016). All this exists alongside rich and diverse indigenous knowledge on the maintenance and utilization of BFA (Padulosi *et al.*, 2013).

The 2011 publication Biodiversity for food and agriculture (FAO and PAR, 2011) starts by stating that worldwide agriculture needs to break its increasing dependence on non-renewable inputs. Signs that policy is shifting in this direction are increasingly evident in Latin America and the Caribbean. National government programmes oriented towards food security and nutrition, such as the Food Acquisition Programme that was part of the Fome Zero Strategy in Brazil, have increased on-farm biodiversity in the smallholder farming systems that characterize family agriculture in the region (Medaets, Pettan and Takagi, 2003; IFPRI, 2015). Public policies promoting agroecology[1] and other forms of biodiversity-rich agriculture are in place or under development at national, district or municipal levels in several of the region's countries (Goulet *et al.,* 2012). Cuba, in particular, serves as a long-standing example, having been utilizing BFA-focused measures to address food insecurity since the 1990s (Funes-Monzote *et al.,* 2010).

Latin America and the Caribbean is experiencing significant changes in its demography, markets, land use and land cover, with an increasingly urban population placing growing demands on agriculture and rural areas (cf. Martinelli, 2012). Bigger and wealthier cities will gradually

[1] Agroecology has been variously defined as a scientific discipline, as a set of farming practices, and as a social movement (Wezel *et al.*, 2009; Tomich *et al.*, 2011). In this report, agroecology is regarded as a scientific approach to agricultural management, following the definition of Gliessman (2006): the use of ecological principles and concepts for the design and management of sustainable food systems. Note that the focus is on the food system, beyond the individual farm or rural community. The science of agroecology differs from classical agronomy in a number of dimensions, as well as in the type of indicators used to assess the performance and sustainability of agricultural production systems (Tittonell, 2014a).

require more and better food, water and energy. Agriculture has a major role to play in meeting these regional demands. At the same time, Latin American soils, water and genetic resources have a key role to play in efforts to achieve food and nutritional security worldwide. In the last decade, about 70 percent of the agricultural and food exports from Latin America and the Caribbean went to Africa and Asia. Demand from these sources is expected to continue growing. Chemically and energy-subsidized crop and animal production are expanding rapidly in the region and this is leading to the disruption of natural mechanisms that underpin the supply of energy, water and nutrients (cf. FAO and PAR, 2011). As a result of these developments, there is a risk that in the near future the region will be unable to meet local and global demands for food and agricultural products. Intensive crop and animal production, as currently practised, depend largely on externally sourced resources and know-how, most of which is produced outside the region.

Through its contributions to greenhouse-gas emissions, nutrient misbalances, biodiversity loss and changes in land and water use, the current food system is largely responsible for the world's critical proximity to environmental planetary boundaries (Eshel *et al.*, 2014; Kahiluoto *et al.*, 2014, Springer and Duchin, 2014). BFA can make a major contribution to reducing the impact of the food system on the environment by enabling the design of agricultural systems that enhance the efficiency of biological processes. Assessing the current state of BFA and its relation to ecosystem services is an essential prerequisite for (i) the development of comprehensive systems approaches to the evaluation of sustainability, (ii) the design of sustainable agricultural production landscapes and (iii) the promotion of sustainable diets among consumers through knowledge-intensive communication campaigns.

I. Assessment and monitoring

1.1 REGIONAL CONTEXT

This report synthesizes the information presented in the country reports submitted by the Bahamas, Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia and Suriname as contributions to the report *The State of the World Biodiversity for Food and Agriculture*.

The total area of land covered by FAO member countries in the region is 2041 million ha. Some 753 million ha are agricultural land, 931 million ha are forest and 38 million ha are water areas, including lakes, rivers and marine coastal zones. Based on the country reports that were submitted and analysed, this report covers about 21 percent of the region's total agricultural, forest and water area (Table 1). Of the 685 million ha covered by the report, 55 percent corresponds to agricultural land, 42 percent to forest and 2 percent to water area.

Table 1. Land and water areas of the countries covered in this synthesis report

Country	Land area (1 000 ha)	Water area (1 000 ha)	Agricultural area (1 000 ha)	Forest area (1 000 ha)
Bahamas	1 001	387	14	515
Costa Rica	5 106	4	1817	2 696
Ecuador	24 836	801	7514	12 705
El Salvador	2 072	32	1582	274
Grenada	34		11	17
Guyana	19 685	1 812	1678	16 546
Jamaica	1 083	16	444	336
Mexico	194 395	2 043	106 705	66 223
Nicaragua	12 034	1 003	5 065	3 114
Panama	7 434	108	2 257	4 650
Peru	128 000	522	24 334	74 308
Saint Lucia	61	1	10.6	20
Suriname	15 600	782	83.2	15 340
TOTAL	411 341	7 511	151 515	196 744

Source: FAOSTAT data for 2014.

Although the area covered by the present report is vast, not all the region's countries submitted a country report and thus some important ecosystems are under-represented.

- The report does not cover Brazil, the Plurinational State of Bolivia, Colombia or Paraguay, countries that host large shares of the Amazon, Chaco and Atlantic forests across climatic gradients. These biodiversity hotspots are partly covered by the country reports of Peru, Ecuador and Suriname.
- The temperate climatic regimes of the Southern Cone of Latin America, corresponding to Chile, Uruguay and the southern highlands of Brazil, are under-represented in the analysis. These are important locations for introduced BFA: "traditional"[1] wheat varieties, chicken landraces, local wine grapes, etc. that have been managed and bred by local farmers since their introduction by Europeans.

[1] Note that the term "traditional" in this context does not necessarily mean native. Introduced species of plants and animals may become traditional after a "certain" amount of time. The length of this period is hard to define, but is enough to allow the species to become culturally embedded and ecologically adapted in the form of landraces. This lack of precision inevitably raises the rhetorical question: when does the introduced become traditional?

- The region of extended plains corresponding to the Orinoco basin, lying within Colombia and the Bolivarian Republic of Venezuela, is not represented in the report. This is an area that deserves attention, as it is experiencing rapid expansion of the agricultural frontier through large agribusiness investments that are displacing traditional family farming and livestock systems.

The report has good coverage of the Andean region, thanks to the reports Ecuador and Peru, and of the wide climatic gradients of Meso and North America, thanks to the reports of Costa Rica, Mexico, Nicaragua and Panama. It also covers several Caribbean countries. Some of the countries covered are considered to be megadiverse, a status they owe to their variations in altitude and their location in the tropics. These countries' ecosystems included wet and dry lowlands and coastal plains, as well as mid-hill valley zones, highland valleys and plains, and highland plateaus. Many of the countries covered in the report host centres of origin of some of the most important crops grown worldwide, including maize, potato, beans and tomato, and of domestic animals such as llamas, alpacas and guinea pigs.

The production systems featured in the various country reports are summarized in Table 2. Several countries reported production systems under the category "others". Such production systems have been incorporated in one or more of the categories presented in Table 2. Mexico reported a rangeland-based livestock system, regarded as distinct from grassland-based livestock

Table 2. Production systems reported in Latin America and the Caribbean

Production system	Countries reporting
Grassland-based livestock systems	Bahamas, Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia, Suriname
Rangeland-based livestock systems[1]	Mexico
Landless livestock systems	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia
Naturally regenerated forests	Bahamas, Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia, Suriname
Planted forests	Costa Rica, Ecuador, El Salvador, Grenada, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia
Self-recruiting capture fisheries	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Nicaragua, Panama, Peru, Saint Lucia, Suriname
Culture-based fisheries	Costa Rica, Ecuador, El Salvador, Jamaica, Panama, Peru
Fed aquaculture	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia, Suriname
Non-fed aquaculture	Costa Rica, Ecuador, El Salvador, Guyana, Jamaica, Panama,
Peru, Saint Lucia, Suriname	
Irrigated rice	Costa Rica, Ecuador, El Salvador, Guyana, Nicaragua, Panama, Peru, Saint Lucia, Suriname
Other irrigated crops[2]	Bahamas, Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Suriname
Rainfed crops[3]	Bahamas, Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia, Suriname
Mixed systems[4]	Bahamas, Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Jamaica, Mexico, Panama, Peru, Saint Lucia, Suriname
Land uses reported as "others"	
Others: Wild-food collection systems	Mexico, Peru
Others: Peri-urban gardening	Saint Lucia
Others: Agroprocessing	Grenada
Others: Crops, swamp system (aroids)	Guyana
Others: Agroforestry	Ecuador

[1] This category includes low-input livestock and honey-bee keeping in forests, shrubby steppes (matorrales, chaparrales), native grasslands and savannahs.
[2] Includes irrigated horticulture.
[3] Includes large-scale monocropping, as reported by some countries.
[4] Includes traditional and organic family-farming systems.
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).

systems.[2] Grasslands in the region include both naturally occurring or human-created grass steppes and prairies consisting of native and adapted-exotic species and ley pastures, regularly re-sown, mostly with exotic species, but also with some native species,[3] and often grown in rotation with annual crops. A differentiation of this kind makes sense not only for Mexico but for most countries in the region, particularly those that have vast areas of shrubby or savannah-like drylands (e.g. the *Caatinga* in Brazil and the *Monte* in Argentina) where grasses may not be the main source of forage for grazing animals.[4] A strict ecological definition of rangelands encompasses a wide range of grazed ecosystems including grasslands, shrublands, woodlands, wetlands and deserts.

Another category that generated some confusion was "irrigated crops". Most vegetable and fruit horticulture in the region takes place under complementary or supplementary irrigation. However, in some locations irrigation is used also for broad-acre crops, such as wheat, maize, potatoes, sugar cane and lucerne, that are normally grown under rainfed conditions – and of course for rice. Irrigating crops using pivot or other aerial systems, only at key moments of the crop season, such as crop establishment or flowering, is not equivalent to producing crops under year-round irrigation using surface flooding, permanent beds or drip systems that require major infrastructure. The types of crop and livestock activities that can be practised in these respective systems influences the level of BFA associated with them. Peri-urban gardening, which was reported as a separate category only by Saint Lucia, may have been reported by most countries as vegetable horticulture, and thus under irrigated crops. Other factors noted in the country reports as constraints to mapping the region's production systems, calculating the area they cover and reporting on the state of BFA in general are summarized in Table 3.

Table 3. Reported constraints to mapping production systems and the state of biodiversity for food and agriculture in Latin America and the Caribbean

Type of constraint	Specific constraints reported	Countries reporting
Insufficient or absence of information, data or monitoring systems	- Lack of data on the area and location of production systems; information systems need improvement - Lack of reliable data to support empirical observations on drivers of change - Outdated information (agricultural census data are 10 or more years old) - Lack of data because research focuses largely on wildlife - Inefficient or total lack of monitoring of the state and use of biodiversity, sustainability, and access and benefit sharing - Lack of information on fisheries and aquaculture systems other than for plankton and commercial-fishery resources; available information is fragmented - Fisheries and aquaculture: lack of definitions and detailed characterization of ecosystems and lack of information on drivers of change - Lack of detailed cartographic information; existing data are simplified and do not include details of ecosystems and interactions	Costa Rica, Ecuador, Grenada, Guyana, Jamaica, Mexico, Panama, Peru, Saint Lucia, Suriname
Insufficient knowledge, academic studies and/or investment in research	- No systematic programme for academic research focused on genetic resources; activities are isolated and disjointed - Lack of scientific studies on genetic resources for food and agriculture - Lack of funding for specific research on biodiversity for food and agriculture - Problems evaluating cultural ecosystems as a consequence of owners' attitudes - Lack of technical capacity and infrastructure for research and conservation of genetic resources - Lack of studies on wild foods	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Panama, Saint Lucia, Suriname

[2] Note, however, that the definition provided by FAO for the ranching (i.e. as opposed to pastoralist) subcategory of grassland system includes the term "rangelands".

[3] Forage crops grown in the region include rye grass and tall fescue in temperate areas, *Bracchiaria*, *Chloris* and *Pennisetum* species in tropical areas and several legume species such as clovers, lucerne and lotus.

[4] It is not always clear from the country reports how areas corresponding to this type of grassland are being reported, i.e. whether as agricultural land or as forest. There are several woodland ecosystems in the region that would fall into the forest category but are used for livestock production.

Table 3 *Cont'd*

Type of constraint	Specific constraints reported	Countries reporting
Insufficient institutional support and investment in agricultural development and biodiversity	- Lack of investment in agriculture - Lack of specific actions targeting use and conservation of associated biodiversity - Lack of institutional capacity related to animal genetic resources - Lack of a specific institution that is in charge of forestry research and basic generation of specialized data - Lack of a land-management/territorial organization - Lack of intersectoral cooperation	Costa Rica, Ecuador, Grenada, Mexico, Panama, Saint Lucia, Suriname
Insufficient time to prepare the report and other dynamic aspects	- Narrowing of the scope of the report due to time constraints - Incomplete consultations with stakeholders from the production and environmental sectors, national and international institutions and civil-society organizations (further efforts will be needed) - Frequent changes in ecosystems and in land use	Costa Rica, Mexico

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

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

The sources and magnitudes of threats to BFA vary from place to place across this vast region and are affected by global drivers such as changes in the climate, international markets and demography. Drivers combine to form "sustainability syndromes" characterized by a range of symptoms inherent in unsustainable agricultural practices that degrade resources and contaminate soil, water and air and erode native germplasm. Only a limited number of the country reports refer explicitly and directly to drivers of change. However, the influence of such drivers is noted at various points in the reports.

Agricultural productivity and the provision of other ecosystem services are severely affected by multiple resource-degradation processes. For instance, water provision to cities located in mountainous valleys (e.g. Mexico City) is seriously compromised by land-use and land-cover changes in surrounding watersheds (Aguilar, 2008).[5] Disruption of the ecological infrastructure of rural landscapes through deforestation and monocropping compromises the provision of ecosystem services such as pollination and pest control and turns common species of birds and mammals into agricultural pests (Garibaldi *et al.*, 2011). Advocacy for land-sparing policies, under which intensive forms of agriculture are utilized with the aim of releasing land from production so that it can be dedicated to nature conservation, has often led to undesirable outcomes in the region, including the conversion of primary forest into intensive oil-palm plantations in some parts of the Amazon region (Gutiérrez-Vélez *et al*., 2011; Gibbs, 2012). Forest protection laws are often met with strong opposition from commercial farmers' organizations that have representatives in politics (e.g. Caceres, Silvetti and Diaz, 2016). In general, signs of resource degradation through rapid loss of biodiversity are already conspicuous in the region, particularly in areas where the agricultural frontier is expanding (e.g. Grau and Aide, 2008; Ran *et al.*, 2013). In most situations, loss of BFA is concomitant with a dwindling of the rural population. Outmigration from rural areas is common in the region, often occurring as a result of a shortage of opportunities for young people (due to remoteness and isolation), inaccessibility of medical care for the elderly or growing insecurity or violence (e.g. Cortez-Arriola *et al.*, 2014).

1.2.1. Associated biodiversity

Some associated-biodiversity species are actively managed to promote the supply of ecosystem services. Others may benefit inadvertently from particular management practices. The first category includes naturally occurring perennial plant species that are deliberately grown

[5] In the particular case of Mexico Valley, the expansion of the urban footprint also threatens the persistence of a form of family farming that maintains a large diversity of traditional maize germplasm.

to provide a range of ecological functions. A typical example of the second category is soil biodiversity, which is influenced by land-use and agricultural practices, but is not necessarily always evident to land managers. Table 4 provides a list of the associated-biodiversity species most frequently mentioned in the country reports as being actively managed for the provision of ecosystem services.

Most of the actively managed associated-biodiversity species mentioned in the country reports are managed for soil formation and protection services, pollination, habitat provisioning, regulation of pests and diseases, and atmospheric regulation. Fewer species are reported to be actively managed for water purification and waste treatment or for nutrient cycling. Some species, such as trees and soil micro-organisms, are reported to be providers of various services.

Actively "managing" biodiversity was frequently taken in the country reports to mean planting or keeping the respective species on farms or in the landscape. In the case of trees and perennial plant species, active management can, for example, involve their introduction into agroecosystems in the form of windrows, hedgerows or woodlots or in multilayer home gardens where they contribute to soil formation and protection, water capture, nutrient cycling, habitat provisioning and microclimate regulation for crops and soil micro-organisms. Actively managing wild species of associated biodiversity, on the other hand, may require more complex mechanisms and institutional support. For example, sea turtles (*Chelonian mydas, Eretmochelys imbricate, Dermochelys coriacea* and *Caretta caretta*) contribute to the maintenance of the sea floor by grazing on seagrass beds, which are breeding grounds for fish and crustacean species. They also contribute to dune fixation through the provision of nutrients to dune grasses via their egg detritus and other dejections. Actively managing sea turtles requires efforts on a broad scale and engagement on the part of a range of actors, including those outside the fisheries and aquaculture sector, whose activities may influence sea-turtle populations.

Table 4. Associated biodiversity species most frequently reported to be actively managed for the provision of ecosystem services in Latin America and the Caribbean

Ecosystem service	Species/other taxonomic group	Countries where species are reported
Pollination	<u>Honey bees:</u> European honey bee (*Apis mellifera*) Mariola (*Tetragonisca angustula*) *Melipona costarricenses* *Scaptotrigona pectoralis* Tamaga (*Cephalotrigona zexmeniae*) <u>Butterflies:</u> Anna's eighty-eight (*Diaethria anna*) Blomfild's beauty (*Smyrna blomfildia*) Brown peacock (*Anartia amathea*) Brown siproeta (*Siproeta epaphus*) Brush-footed butterfly (*Adelpha basiloides*) *Fountainea eurypyle* Gold-edged owl butterfly (*Caligo uranus*) Janais patch (*Chlosyne janais*) Julia butterfly (*Dryas iulia*) Passion butterfly (*Agraulis vanillae*) Small postman (*Heliconius erato*) Zebra longwing (*Heliconius charitonia*) <u>Birds:</u> Black-billed streamertail (*Trochilus scitulus*) Mango hummingbirds (*Anthracothorax* spp.) Red-billed streamertail (*Trochilus polytmus*)	Jamaica, Mexico, Nicaragua, Panama, Peru

Table 4 *Cont'd*

Ecosystem service	Species/other taxonomic group	Countries where species are reported
Pest and disease regulation	Citrus cultivation (Peru): Cardinal ladybird (*Novius cardinalis*) Fly (*Leucopis* spp.) Lacewing (*Sympherobius* spp.) Wasp (*Amitus spinifera*) Wasp (*Anagyrus* spp.) Wasp (*Aphytis holoxanthus*) Wasp (*Aphytis lepidosaphes*) Wasp (*Aphytis roseni*) Wasp (*Cales noacki*) Wasp (*Coccophagus* spp.) Wasp (*Eretmocerus paulistus*) Wasp (*Leptomastidea* spp.) Wasp (*Metaphycus luteolus*) Wasp (*Prospaltella porteri*) Apple cultivation (Peru): Wasp (*Aphelinus mali*) Potato cultivation (Peru): Wasp (*Chrysocharis* spp.) Wasp (*Closterocerus* spp.) Wasp (*Diglyphus* spp.) Wasp (*Ganaspidium* spp.) Wasp (*Opius* spp.) Wasp (*Zagrammosoma* spp.) Olive cultivation (Peru): Bacteria (*Bacillus thurigiensis*) Chinita (*Clistotetus arcuatus*) Green lacewings (*Chrysopidae family*) *Scutellista cyanea* Wasp (*Coccophagus rusti*) Wasp (*Metaphycus helvolus*) Wasp (*Metaphycus lounsburyi*) Wasp (*Trichogramma* spp) Invasive species control: Parrotfishes (Scarinae subfamily) and other herbivorous fish species (control of macro-algal overgrowth) Unspecified: Arbuscular mycorrhizal fungi Bacteria (*Xenorhabdus* spp.) Douglas fir (*Pseudotsuga menziesii*) Encyrtid wasp (*Gyranusoidea indica*) Firs (*Abies* spp.) Fruit fly (*Ceratitis capitata*)-sterile insect technique Fungus (*Beauveria bassiana*) Fungus (*Isaria* spp.) Fungus (*Metarhizium anisopliae*) Fungus (*Paecilomyces lilacinus*) Fungus (*Trichoderma* spp.) Limia fish (*Limia* spp.) Nematode (*Steinernema* spp.) Parasitoid wasp (*Anagyrus kamali*) Pasture killer (*Senna reticulata*) Pines (*Pinus* spp.) Tephritid flies (*Anastrepha* spp.) – sterile insect technique Wasp (*Cotesia flavipes*)	Ecuador, Guyana, Jamaica, Mexico, Nicaragua, Panama, Peru, Saint Lucia, Suriname

Table 4 *Cont'd*

Ecosystem service	Species/other taxonomic group	Countries where species are reported
Water purification and waste treatment	Microalgae for treatment of residual water (Peru): Green algae (*Chlorella* spp.) Improving water quality/filtering pollutants from water running off land before entering the sea: Mangrove ecosystems Unspecified: Aquatic insects (Hemiptera and Coleoptera) Black mangrove (*Avicennia germinans*) Buttonwood (*Conocarpus erectus*) California bulrush (*Schoenoplectus californicus*) Duckweed (Lemnoideae family) Giant cane (*Arundo donax*) Red mangrove (*Rhizophora mangle*) Water hyacinth (*Eichhornia crassipes*) White mangrove (Laguncularia racemosa)	Ecuador, Jamaica, Mexico, Panama, Peru
Natural hazard regulation	Alder (*Alnus* spp.) Blue gum (*Eucalyptus globulus*) Capirona (*Calycophyllum spruceanum*) Giant cane (*Arundo donax*) *Guazuma crinita* Mangrove forests Polylepis spp. Prosopis spp. Vetiver (*Chrysopogon zizanioides*)	Ecuador, Jamaica, Panama
Nutrient cycling	Vermiculture: Red worm (*Eisenia fetida*) Non specified: Bacteria (*Pseudomonas* spp.) Bacteria (*Azotobacter* spp.) Black mangrove (*Avicennia germinans*) Buttonwood (*Conocarpus erectus*) Fungus (*Trichoderma* spp.) Guinea grass (*Megathyrsus maximus*) Nitrogen-fixing bacteria (*Azospirillum* spp.) Red mangrove (*Rhizophora mangle*) Rhizobacteria White mangrove (*Laguncularia racemosa*)	Ecuador, Mexico, Nicaragua
Soil formation and protection	Rebuilding and replenishment of sand particles: Parrot fishes (Scarinae subfamily) and other herbivorous fish species Planting of trees and plants: Acacia (*Acacia coulteri*) *Acosmium panamense* Albizia (*Hesperalbizia occidentalis*) *Alnus acuminata* Arizona pine (*Pinus arizonica*) Ayacahuite pine (*Pinus ayacahuite*) Beechwood (*Gmelina arborea*) Black mangrove (*Avicennia germinans*) Buttonwood (*Conocarpus erectus*) Cacao (*Theobroma cacao*) *Chamaedorea graminifolia* *Chamaedorea pochutlensis* *Chamaedorea quetzalteca* Chiapas pine (*Pinus chiapensis*) *Colpothrinax aphanopetala*	Ecuador, Jamaica, Mexico, Panama, Peru

Table 4 *Cont'd*

Ecosystem service	Species/other taxonomic group	Countries where species are reported
	Cyathea fulva Douglas fir (*Pseudotsuga macrolepis*) Ernest August' s palm (*Chamaedorea ernesti-augusti*) *Euterpe precatoria* Giant viznaga (*Echinocactus platyacanthus*) Glassywood (*Astronium graveolens*) Gregg's pine (*Pinus greggii*) Guanacaste (*Enterolobium cyclocarpum*) Guinea grass (*Panicum maximum*) Holywood (*Guaiacum sactum*) Ironwood (*Olneya tesota*) Jalisco pine (*Pinus jaliscana*) Jeffrey pine (*Pinus jeffreyi*) Kapok (*Ceiba pentandra*) Linaloe tree (*Bursera linanoe*) *Lysiloma divaricata* Mahogany (*Swietenia macrophylla*) Martinez pinyon (*Pinus maximartinezii*) Mauto (*Lysiloma divaricatum*) Maya nut (*Brosimum alicastrum*) Mexican juniper (*Juniperus flaccida*) Mexican white cedar (*Callitropsis lusitanica*) Mexican white cedar (*Cupressus lusitanica*) Old man cactus (*Cephalocereus senilis*) *Orbignya guacuyule* *Oreomunnea mexicana* Pacific Coast mahogany (*Swietenia humilis*) Parry pinyon (*Pinus quadrifolia*) Peach-palm (*Bactris gasipaes*) *Pinus martinezii* *Quercus laurina* Red mangrove (*Rhizophora mangle*) Sacred fir (Abies religiosa) Single-leaf pinyon (*Pinus monophylla*) Smooth mesquite (*Prosopis laevigata*) Spanish cedar (*Cedrela odorata*) Texas ebony (*Ebenopsis ebano*) Vetiver (*Chrysopogon zizanioides*) White leadtree (*Leucaena leucocephala*) <u>Not specified:</u> Springtail (Hypogastruridae, Entomobryidae, Sminthuridae families) <u>Nitrogen fixation:</u> (*Azospirillum* spp.) <u>Phosphorus solubilizing:</u> (*Pseudomonas* spp.)	
Water cycling	<u>Not specified:</u> (*Myrcianthes* spp.) *Alnus acuminata* Blue gum (*Eucalyptus globulus*) Caddisflies (Trichoptera) Coco (*Lecythis ampla*) Mayflies (Baetidae, Leptohyphidae families) Dragonflies and damselflies (Odonata) Peruvian pepper (*Schinus molle*) Tamarind (*Tamarindus indica*) True bugs (Hemiptera)	Ecuador, Panama

Table 4 *Cont'd*

Ecosystem service	Species/other taxonomic group	Countries where species are reported
Habitat provisioning	Habitat provisioning for fungus production: *Pinus radiate* – production of edible fungus by symbiotic action Habitat provisioning for butterflies: Guayacan (*Lignum vitae*) for lignum vitae butterfly (*Kricogonia lyside*) Habitat provisioning for fish species, shellfish, crustaceans: Mangrove wetlands Grazing of sea grass by turtles and maintaining the health of the seagrass beds, which are the breeding and developmental grounds for fish species, shellfish and crustaceans that are harvestable as food for humans: Green sea turtle (*Chelonia mydas*) Hawksbill sea turtle (*Eretmochelys imbricata*) Leatherback sea turtle (*Dermochelys coriacea*) Loggerhead sea turtle (*Caretta caretta*) Coraline species (critical habitat for fish species): Hump coral (*Porites furcata*) Thin leaf lettuce coral (*Agaricia tenuifolia*) Yellow finger coral (*Madracis auretenra*) Dune vegetation maintenance Green sea turtle (*Chelonia mydas*) (Nutrients from turtle eggs help to maintain dune vegetation) Planting of trees and plants: *Acosmium panamense* *Alnus acuminata* Black mangrove (*Avicennia germinans*) Buttonwood (*Conocarpus erectus*) Cacao (*Theobroma cacao*) *Caesalpinia brasiliensis* *Chamaedorea graminifolia* *Chamaedorea pochutlensis* *Chamaedorea quetzalteca* Chiapas pine (*Pinus chiapensis*) *Cyathea fulva* Douglas fir (*Pseudotsuga macrolepis*) Ernest August's palm (*Chamaedorea ernesti-augusti*) Giant viznaga (*Echinocactus platyacanthus*) Glassywood (*Astronium graveolens*) Holywood (*Guaiacum sactum*) Ironwood (*Olneya tesota*) Jalisco pine (*Pinus jaliscana*) Jeffrey pine (*Pinus jeffreyi*) Martinez pinyon (*Pinus maximartinezii*) Mexican white cedar (*Callitropsis lusitanica*) Musaceae family Old man cactus (*Cephalocereus senilis*) *Orbignya guacuyule* Peach-palm (*Bactris gasipaes*) Peruvian pepper (*Schinus molle*)	Jamaica, Mexico, Panama

Table 4 *Cont'd*

Ecosystem service	Species/other taxonomic group	Countries where species are reported
	Pinus martinezii *Polylepis australis* Red mangrove (*Rhizophora mangle*) Single-leaf pinyon (*Pinus monophylla*) Spanish cedar (*Cedrela odorata*) Tamarind (*Tamarindus indica*) Walnut trees (*Juglans* spp.) White mangrove (*Laguncularia racemosa*) <u>Not specified:</u> Arapaima (*Arapaima gigas*)	
Production of oxygen, gas regulation	<u>Planting of trees and plants:</u> *Acosmium panamense* *Alnus acuminata* Black mangrove (*Avicennia germinans*) Blue gum (*Eucalyptus globulus*) Buttonwood (*Conocarpus erectus*) Cacao (*Theobroma cacao*) Canistel (*Pouteria campechiana*) *Chamaedorea graminifolia* *Chamaedorea pochutlensis* *Chamaedorea quetzalteca* Chiapas pine (*Pinus chiapensis*) Coco (*Lecythis ampla*) Coffee plant (*Coffea arabica*) Colombian walnut (*Juglans neotropica*) *Cyathea fulva* Douglas fir (*Pseudotsuga macrolepis*) Ernest August's palm (*Chamaedorea ernesti-augusti*) Giant viznaga (*Echinocactus platyacanthus*) Glassywood (*Astronium graveolens*) Guabito (*Inga multijuga*) Holywood (*Guaiacum sactum*) Ironwood (*Olneya tesota*) Jalisco pine (*Pinus jaliscana*) Jeffrey pine (*Pinus jeffreyi*) Lemonwood (*Calycophyllum candidissimum*) Martinez pinyon (*Pinus maximartinezii*) Mexican white cedar (*Callitropsis lusitanica*) Musaceae family *Myrcianthes leucoxyla* Nance macho (*Clethra lanata*) Old man cactus (*Cephalocereus senilis*) *Orbignya guacuyule* Parry pinyon (*Pinus quadrifolia*) Peach-palm (*Bactris gasipaes*) Peruvian pepper (*Schinus molle*) Pink poui (*Tabebuia rosea*) *Pinus martinezii* Red mangrove (*Rhizophora mangle*) Seagrass beds Single-leaf pinyon (*Pinus monophylla*) Spanish cedar (*Cedrela odorata*) Tamarind (*Tamarindus indica*) Tara (*Caesalpinia spinosa*) White mangrove (*Laguncularia racemosa*)	Ecuador, Jamaica, Mexico, Panama

Table 4 *Cont'd*

Ecosystem service	Species/other taxonomic group	Countries where species are reported
Others: useful in the application of productive conservation systems	Araza (*Eugenia stipitata*) *Chrysophyllum venezuelanense* Coco (*Lecythis ampla*) Madrono (*Garcinia madruno*) *Ocotea raimondii* Panama hat plant (*Carludovica palmata*) Tamarind (*Tamarindus indica*) Tara (*Caesalpinia spinosa*)	Ecuador

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

The inventory and monitoring of associated biodiversity and the functions and services it provides are a precondition for its proper conservation and management to the benefit of agricultural and food production. Table 5 summarizes the information provided in the country reports on national information systems. Good examples of national-level information systems include Peru's National Environmental Information System and Mexico's National Information System on Natural Resources. Some countries reported that national information systems still need to be created. El Salvador's country report refers to technological constraints hampering the creation of a national information system. As can be seen from Table 5, some countries referred to programmes, ministries, institutes, universities, laboratories, museums, encyclopaedias or other sources of information that do not, strictly speaking, constitute information or monitoring systems. Some countries (e.g. Suriname) monitor species that are considered invasive or potential agricultural pests. Often the bodies that monitor agricultural pests are disconnected from those that are in charge of monitoring associated biodiversity. National-level initiatives to monitor ecosystem functions and services provided by associated biodiversity were not reported. Frameworks for evaluating ecosystem services are available and are known to scientific, policy-making and agricultural-extension communities (e.g. the ECOSER protocol in Argentina – Laterra, Castellarini and Orué, 2011), yet their adoption by national governments in the region remains rather incipient.

Table 5. National information systems for associated biodiversity reported in Latin America and the Caribbean

Country	National information systems reported
Costa Rica	- Costa Rica National Museum (ECOBIOSIS): http://ecobiosis.museocostarica.go.cr - INBio's ATTA database - National Bibliography on Tropical Biology: https://croweb.ots.ac.cr/rdmcnfs/datasets/exsrch.phtml?ds=binabitrop - Global Biodiversity Information Facility: http://www.gbif.org - Atlas of Living Costa Rica : http://www.crbio.cr/crbio - In Costa Rica: Information Network on Invasive Species
Ecuador	- The Ministry of the Environment's Biodiversity Information System of Ecuador: http://sib.ambiente.gob.ec - The "DiserLab" laboratory and the Faculty of Natural Resources of the Escuela Superior Politécnica de Chimborazo, which identifies micro-organism diversity - Encyclopaedia of Useful Plants of Ecuador - The information system of the Ecuadorian Institute of Intellectual Property – a register of traditional knowledge, cultural expressions and associated genetic resources
El Salvador	- National Centre for Agricultural and Forest Technology "Enrique Alvarez Cordoba" - José Matías Delgado University - University of El Salvador - Catholic University of El Salvador
Guyana	- Guyana Wildlife Management Authority
Jamaica	- Jamaica Clearing House Mechanism hosted by the Institute of Jamaica

Table 5 *Cont'd*

Mexico	- National Environmental and Natural Resources Information System http://www.gob.mx/semarnat/acciones-y-programas/sistema-nacional-de-informacion-ambiental-y-de-recursos-naturales - National Information System of the Agrifood and Fisheries Sector - Norms for the protection of fauna associated with shrimp cultivation, marine mammals, tunids and other fish by-catch and marine turtles - Monitoring systems for wildlife populations and wild animal diseases - Monitoring of animal species that are potential agriculture pests or threats to human health - Monitoring of potential invasive species - Permanent monitoring sites for forests (structure and growth) - Monitoring programmes for imports of Christmas trees and processed woods in terms of pests and diseases - Ministry of the Environment and Natural Resources: http://www.gob.mx/semarnat
Nicaragua	- National Environmental Information System: http://www.sinia.net.ni/
Panama	- Monitoring of biodiversity in the Alto Chagres, including aquatic insects, orchid pollinators, amphibians, bats and other species (ANAM, 2014; SOMASPA, 2016) - Smithsonian Tropical Research Institute database on associated biodiversity: http://biogeodb.stri.si.edu/biodiversity/ - Species distribution of Epyrinae subfamily (Hymenoptera: Bethylidae) in seven provinces (Santos and Gonzalez, 2006) - Faculty of Natural and Exact Sciences and Technology of the University of Panama - Autonomous University of Chiriqui
Peru	- National Information Platform on Biological Diversity - BIOCAN Programme of the Andean Community - Project: Census of Marine Biodiversity in Peru - National Open Access Digital Repository: https://portal.concytec.gob.pe/index.php/informacion-cti/alicia - Dinoflagellates database of the National Organization for Fish Health (in development) - Geographical Information System of the Ministry of the Environment: http://geoservidor.minam.gob.pe - National Forest and Wildlife Information System: https://www.serfor.gob.pe/sniffs - National Forest Cover Monitoring System - Peruvian Amazon Research Institute's Information System for the Biological and Environmental Diversity of the Peruvian Amazon: http://190.187.112.91/siamazonia/Principal.aspx - National Environmental Information System: http://sinia.minam.gob.pe
Saint Lucia	- National Biodiversity Information Network

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

1.2.2 Wild food species

The region has a unique range of wild food species. For example, Peru alone has 523 species of edible fruits, of which only 66 are domesticated, 149 are either cultivated or found in the wild, and the rest are collected directly from the wild. Nicaragua's report mentions a series of studies that provide information on some 150 wild and domesticated plant species, found mostly in well-conserved forests and used mainly by indigenous communities and by communities of African origin living on the country's Caribbean coast. The species most frequently reported by the countries in the region are presented in Table 6. Most frequently reported were terrestrial mammals, followed by terrestrial plants and freshwater fish. Some species of birds were also reported, as well as one reptile and one crustacean species. Table 6 shows wild food species reported by more than one country. Individual countries provided much longer lists. The country report of Mexico, for instance, includes a total of 186 wild food species.

The inventory and monitoring of wild food species in the region generally leaves much to be desired. Nicaragua lists several domesticated plant species in this section of its report, including some 611 genotypes of creole grains, 203 fruit species, 157 cocoa varieties and 54 grass and fodder species. This information, while highly valuable and interesting, does not provide a good overview of the status of wild food species. Some countries may not have reported wild species used for food if their use is currently forbidden for conservation-related reasons (e.g. certain trout species). Countries such as Costa Rica, which delivered an otherwise comprehensive report, indicated that there is not enough information in the country to provide proper assessments of the utilization of wild food species and the threats affecting them, and proposed that more support should be given to ethnobotanical research. Published scientific studies indicate at least 46 underutilized native edible species in Costa Rica (González, 2008).

Table 6. Wild food species reported by two or more countries in Latin America and the Caribbean

Wild food species	Common name	Countries where species is reported
Freshwater fish		
Arapaima gigas	Arapaima	Ecuador, Peru
Colossoma macropomum	Tambaqui	Ecuador, Peru
Oncorhynchus mykiss	Rainbow trout	Ecuador, Peru
Piaractus brachypomus	Pacu	Ecuador, Peru
Prochilodus nigricans	NA	Ecuador, Peru
Crustaceans		
Anadara tuberculosa	NA	El Salvador, Peru
Litopenaeus vannamei	Whiteleg shrimp	Ecuador, Peru
Reptiles		
Iguana iguana	Green iguana	Grenada, Mexico, Panama
Plants		
Agave americana	Century plant	Ecuador, Peru
Bactris gasipaes	Peach palm	Ecuador, Panama
Dioscorea villosa	Wild yam	Grenada, Panama
Hymenaea coubaril	Stinking toe	El Salvador, Grenada
Jatropha curcas	Barbados nut	Ecuador, Peru
Mauritia flexuosa	Moriche palm	Ecuador, Peru
Psidium guajava	Common guava	Ecuador, Peru
Spondias purpurea	Jocote	Ecuador, El Salvador
Theobroma bicolor	Mocambo tree	Ecuador, Peru
Vitex gigantea	NA	Ecuador, Peru
Birds		
Penelope purpurascens	Crested guan	Ecuador, Mexico
Zenaida asiatica	White-winged dove	El Salvador, Mexico
Game species		
Agouti paca	Paca	El Salvador, Mexico, Peru
Cuniculus paca	Lowland paca	Ecuador, Mexico
Dasyprocta punctata	Central American agouti	El Salvador, Mexico, Peru
Dasypus novemcinctus	Nine-banded armadillo	Ecuador, El Salvador, Grenada, Mexico
Mazama americana	Red brocket	Ecuador, Mexico, Peru
Mazama gouazoubira	Grey brocket	Mexico, Peru
Odocoileus virginianus	White-tailed deer	Ecuador, El Salvador, Mexico, Peru
Pecari tajacu	Collared peccary	Ecuador, El Salvador, Mexico, Peru
Tapirus terrestris	South American tapir	Ecuador, Peru
Tayassu pecari	White-lipped peccary	Ecuador, Peru
Tayassu tajacu	Collared peccary	Ecuador, El Salvador, Mexico, Peru

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

A category of biodiversity that sits somehow between associated biodiversity and wild-food species is that of medicinal species, which were repeatedly mentioned in the country reports. While the contribution of different botanical families to medicinal and wild food resources differs across ecological regions, a study by Bermúdez and Ramos Chue (2014) notes that a wide range of medicinal plant species are used by indigenous communities in Panama, even in peri-urban areas.

1.2.3 Summary of country assessments on drivers and trends

The country reports differed in the level of detail with which the various trends and drivers of change related to associated biodiversity, ecosystem services (regulating and supporting) and wild food resources were reported. Some of the drivers that were most commonly mentioned, not in order of frequency, were:

- replacement of local production systems and genetic resources;
- emergence of new weeds, pests and diseases;
- adverse climatic factors (frost, drought, floods);
- uncontrolled fire;
- overgrazing and overexploitation of wild species;
- urbanization and population pressure;
- migration;
- inadequate policies and legislation;
- inequity and other social problems; and
- hunger and poverty.

The frequency with which these processes were reported as drivers of change for biodiversity differed between country reports. Panama's country report provides a broad overview and scoring of the impact of drivers of change on associated biodiversity, ecosystem services and wild food resources, spanning its various agroecosystems. A noteworthy driver of change that is reported to have very negative effects on several ecosystem services in Panama is the emergence and current expansion of mining activities (gold and copper), fuelled by high international prices. This trend is also mentioned in the reports of Peru and Mexico. Mining disrupts entire ecosystems, affecting the availability and diversity of wild food species and knowledge of these resources, as well as incentivizing rural people to move out of agriculture.

The countermeasures that have been put in place to reduce the impact of drivers of change on associated biodiversity, ecosystem services and wild food species were not reported in great detail in the country reports, albeit with some exceptions (Box 1). The report of Mexico, following the approach of Challenger and Dirzo (2009), distinguishes root factors from direct or proximal factors. The first category includes demographic trends, such as population growth rate and density, as well as governance, policy, economic and cultural factors. The direct or proximate factors include changes in land use and cover, natural-resource extraction, invasive exotic species, pollutants, climate change and transaction costs associated with the implementation of sectoral policies.

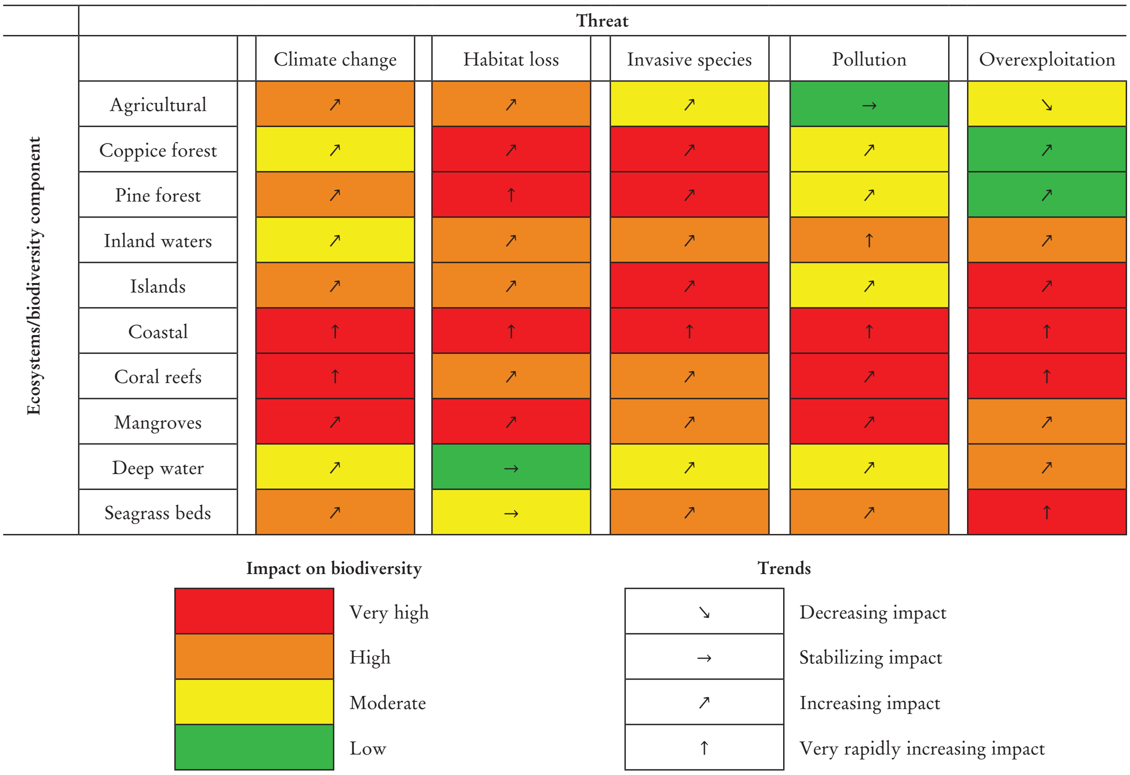
The report of Costa Rica illustrates some trends by means of key indicators (Table 7). It also identifies ecosystem types that are increasing in their extent or conservation quality (e.g. mature native forest and secondary forest) and types that are diminishing in their extent and/or quality (e.g. mangroves, páramos [highland moorlands], palm forests, lakes and shallow lakes, subterranean waters and rivers). The report of the Bahamas provides a graphical representation of drivers and their impacts on biodiversity components, focusing on climate change, habitat loss, invasive species, pollution and overexploitation of natural resources (Figure 1). Coastal coral reefs and mangroves are among the components of biodiversity most seriously threatened by these drivers in the Bahamas.

Table 7. Threats to biodiversity, indicators and trends reported by Costa Rica

Threat to biodiversity	Indicator	Trend
Loss of habitat	Net forest cover	Increasing
	Forest degradation	Decreasing
	Loss of ecosystems such as mangroves, *páramos*	Decreasing
	Forest fires in unprotected areas	Increasing
	Forest fires in protected areas	Decreasing
Unsustainable extraction, resource overexploitation	Illegal deforestation	No change
	Populations of commercial fish and crustacean species	Decreasing
Contamination, sedimentation	Pesticide use intensity (per ha)	Increasing
	Sanitary quality of beaches, marshlands and rivers	Decreasing
	Environmental conflicts	Increasing
Climate change	Water deficit	Increasing
	Temperature (air and sea surface)	Increasing

Source: Country report of Costa Rica.

Figure 1. Summary of the status and trends of, and threats to, biodiversity as reported by the Bahamas



Source: Country report of the Bahamas (previously published in Government of the Bahamas, 2011).

Box 1. Countermeasures taken to reduce adverse effects of drivers of change on biodiversity for food and agriculture: examples from Mexico

Mexico is a megadiverse country and the centre of origin of several cultivated and wild food species. To preserve this biodiversity and the ecosystem services it provides, Mexico has adopted a number of countermeasures to reduce the adverse effects of drivers of change. For example, out of the more than 60 thousand species kept in the national Network of Conservation Centres, more than 10 thousand are wild relatives of major food crops. The crops with the largest number of protected species are orchids, cactuses, agaves, bromeliads and beans.

Other mechanisms include:

- supporting the diversification of production systems through the inclusion of wild food species and connecting them to integrated value chains;
- supporting participatory breeding of traditional and local varieties for *in situ* conservation (e.g. cacao, walnuts, tejocote, guayaba);
- establishing community conservation banks for agrobiodiversity (26 throughout the country); and
- providing incentives to farmers for the conservation of native maize varieties.

The latter mechanism, in particular, has led to the conservation of 90 percent of Mexico's reported maize genetic diversity, including 27 landraces in the country's northern region, 18 in the central region and 19 in the southern region.

Source: Country report of Mexico.

1.3 NEEDS AND PRIORITIES

The main reported needs and priorities in terms of the assessment and monitoring of BFA, and in particular of associated biodiversity, wild foods and ecosystem services, are summarized, by country, in Table 8. Countries that do not currently have an inventory of BFA or do not have monitoring systems in place indicated that developing these is priority. The need to collect data and create public databases on associated biodiversity and wild foods was often mentioned. Countries that have such systems in place indicated the need for more trained personnel and more material and human resources. Some countries reported that relevant laws and legal mechanisms have already been approved but have not yet been promulgated or implemented, and indicated that this is a priority. Reported research needs included the design of national inventories, studies on the impact of current agricultural, forestry and livestock practices on associated biodiversity and ecosystem services, and studies on the design of sustainable agricultural systems based on efficient use of BFA. The need to communicate knowledge and research results to the wider society, especially to policy-makers and decision-makers, was mentioned as a priority in many reports.

Table 8. Reported needs and priorities for the assessment and monitoring of biodiversity for food and agriculture in Latin America and the Caribbean

Country	Needs and priorities
Costa Rica	- National-level diagnosis - Implementation of national policies on biodiversity and sustainable agriculture - Studies on pollinators, especially insects - Studies on climate change impact on flora and fauna - Research on, and wider communication of, the roles of biodiversity in agricultural systems - Capacity-building among technicians and farmers on associated biodiversity - Knowledge generation on soil micro-organisms and forest growth - Complete country inventories of associated biodiversity, especially pollinators - Establishment of buffering and connecting areas for biodiversity in agricultural systems - Promotion of biodiversity-rich farming systems
Ecuador	- A research programme to improve knowledge of biodiversity at country level - Baseline studies and indicator-based assessments of climate change impacts - Studies on genetic resources pertaining to beneficial soil organisms - Promotion of the use and protection of beneficial soil organisms
El Salvador	- Development of a national inventory on biodiversity and genetic resources for food and agriculture - Hiring of trained human resources - Capacity-building among current personnel on assessment of associated biodiversity - Investment in infrastructure and equipment - Capacity-building among technicians and farmers on *in situ* and *ex situ* conservation and on assessment of associated biodiversity - National programmes on genetic resources management - National strategies, priorities and multidisciplinary teams
Grenada	- Enhancement of data collection to provide a better grasp of the intricacies and complexities associated with the drivers affecting biodiversity - Development of human resources in fields related to biodiversity - Improved documentation of knowledge of wild foods and improved training to support research on wild foods
Jamaica	- Data collection that focuses not only on species numbers but also on the use of species as food
Mexico	- Redesign of biodiversity protection programmes, improvements to human capacities and broader communication - Improvements to knowledge dissemination and protection of wild forests - New legislation on the protection of aquaculture and fishery resources - Public policies, intersectoral projects and better dissemination of current activities - An interministerial department to develop public policies on conservation and use of biodiversity
Panama	- An interagency database on genetic resources, biodiversity, ecosystems and the environment, with regular updates on collections, laws, institutions, experts, publications, projects, traditional knowledge, etc. - Support for researchers and experts in the field of biodiversity
Peru	- Inventory of biodiversity in production systems - Better diffusion of the results of studies on associated biodiversity to decision-makers - Studies on the distribution and dynamics of biodiversity at national level - Assessment of invasive and exotic forest species
Suriname	- Because of the limited availability of information and the shortage of specialists in the field of biodiversity and wild foods, no in-depth plans have been developed. Assistance needs to be provided in the field of planning, and finance should be made available to ensure that plans are implemented. As Suriname has only used approximately 10 percent of its land surface for economic purposes, detailed plans for sustainable use are in their infancy, especially in the case of wild foods and agriculture.

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

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

2.1 SUSTAINABLE USE

The sustainable use and maintenance of BFA in farming landscapes depends – and will increasingly depend – on the value that society as a whole, and decision-makers in particular, ascribe to its various roles. The roles of biodiversity for food and agriculture can be grouped into three major categories:

- the contribution of biodiversity to food security and nutrition;
- the co-dependence between biodiversity and ecosystem services; and
- the biodiversity-mediated mechanisms of resilience and adaptability of agroecosystems in the face of shocks and stresses.

Table 9 provides a list of the most frequently reported management and diversity-based practices that support the maintenance and use of BFA and summarizes reported trends in their use. The information reported highlights some important regional trends, such as a general decline in the use of integrated pest and nutrient management and an increase in the use of diversity-based strategies such as the domestication of wild species and the use of native tree diversity for the maintenance or conservation of landscape complexity.

Table 9. Reported trends in the adoption of selected management practices and approaches in Latin America and the Caribbean

Practice or approach	Production systems	Countries reporting	Reported trends in adoption
Agroforestry	Grassland based livestock systems, forest (secondary and planted), irrigated and rainfed cropping systems, mixed systems, capture fisheries, aquaculture	Costa Rica, Ecuador, El Salvador, Grenada, Mexico, Panama, Peru, Saint Lucia	Increasing in the case of livestock systems, stable or decreasing in cropping and mixed systems
Conservation agriculture	Irrigated and rainfed cropping systems, grassland-based and landless livestock systems, mixed systems, planted forests	Costa Rica, Ecuador, El Salvador, Grenada, Mexico, Panama Saint Lucia	Increasing in most regions, especially in cropping systems, decreasing in mixed systems in the Andes
Integrated plant nutrient management	All plant-based production systems, grassland-based livestock systems, naturally regenerated forests, planted forests, mixed systems	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Mexico, Panama, Peru	Decreasing in cropping and mixed systems, increasing in other systems; in many cases no information provided or use reported to be stable Costa Rica and El Salvador reported that use is increasing in livestock grassland-based systems Ecuador and Grenada reported that use is increasing in irrigated and rainfed cropping systems and in mixed systems Costa Rica reported that use is increasing in mixed systems.
Integrated pest management	All production systems	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Mexico, Nicaragua, Panama, Peru	Decreasing in landless livestock systems, in cropping and mixed systems in the Andes, increasing in aquaculture and forestry Increasing in Ecuador and Panama in cropping systems Mexico and Ecuador reported increases in mixed systems

Table 9 *Cont'd*

Practice or approach	Production systems	Countries reporting	Reported trends in adoption
Pollination management	All plant-based production systems	Costa Rica, El Salvador, Grenada, Mexico, Nicaragua, Peru	Generally increasing Decreasing in cropping and mixed systems in the Andes Increasing in mixed systems in Costa Rica
Landscape management	All production systems except landless livestock systems	Costa Rica, Ecuador, El Salvador, Mexico, Peru	Decreasing in livestock and mixed systems in the Andes and increasing rapidly in mixed systems in Central America Ecuador reports increases in livestock grassland-based systems and in planted forests
Sustainable soil management practices	All soil-based systems (livestock, forest, crops)	Costa Rica, Ecuador, El Salvador, Grenada, Mexico, Nicaragua, Peru	Increasing or unchanged Grenada reports a strong decrease in irrigated cropping systems and a decrease in rainfed cropping and mixed systems
Organic agriculture	All production systems	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Mexico, Panama, Peru, Saint Lucia	Increasing or unchanged
Low external input agriculture	All plant-based production systems	Costa Rica, Ecuador, El Salvador, Grenada, Mexico, Peru	Decreasing in cropping systems in Grenada and Ecuador Increasing or unchanged in the other cases
Home gardens	All production systems, presumably sharing areas within other production systems	Costa Rica, Ecuador, El Salvador, Grenada, Guyana, Mexico, Peru	Decreasing in cropping and mixed systems, increasing or unchanged in the other cases
Ecosystem approach to capture fisheries	Self-recruiting capture fisheries	Costa Rica, Jamaica, Mexico, Panama	Jamaica reports a strong increase in self-recruiting capture fisheries Mexico and Panama report increases
Reduced-impact logging	All land-based production systems	Costa Rica, Ecuador, El Salvador, Mexico, Panama, Peru	Increasing or no change El Salvador reports a decrease in planted and naturally regenerated forests
Diversification	All production systems	Costa Rica, Ecuador, Grenada, Guyana, Mexico, Nicaragua, Peru, Saint Lucia	Increasing in all cases reported except in mixed systems in Mexico and Grenada
Base broadening	All production systems	Costa Rica, Ecuador, Grenada, Guyana	Increasing or no change
Domestication	All production systems	Costa Rica, Ecuador, Guyana, Mexico, Peru	Increasing in most cases, very strongly in aquaculture in the Andes
Restoration practices	All production systems	Costa Rica, Ecuador, Grenada, Mexico, Panama, Peru	Increasing or no trend Decreasing in irrigated cropping systems in Ecuador and in mixed systems in Grenada
Management of micro-organisms	All land-based production systems	Costa Rica, Ecuador, Mexico, Peru	Increasing or no change, except in irrigated cropping systems in Ecuador
Polyculture/aquaponics	Aquaculture and mixed systems in the Andes, all production systems in the rest	Costa Rica, Ecuador, Guyana, Mexico, Peru, Saint Lucia	Increasing or no change Decreasing in mixed systems in Mexico and in irrigated crops in Ecuador
Enriched forests	All production systems	Costa Rica, Grenada	No change Increasing in Grenada

Source: FAOSTAT data for 2014.

2.1.1 Biodiversity and human nutrition

BFA is essential to the four pillars of food security: (i) availability, because it contributes to producing more of a diverse portfolio of crops and animals on-farm or in the landscape and allows niche complementarities to be explored through polycultures; (ii) access, because it promotes locally diverse production on-farm, with positive effects in terms of diversification, substitutability, supply and price stability in local and national markets; (iii) stability, because it contributes to building resilient food systems through biodiversity-mediated mechanisms for coping with and adaptation to external shocks and stresses; and (iv) utilization, because vitamins and essential minerals present in a diverse diet prevent diseases associated with their deficiency, which are often the result of the inability to absorb and utilize major nutrients contained in staple foods.

As incomes rise, the region is undergoing a rapid transition towards a so-called "western" diet, dominated by refined sugars and carbohydrates, refined fats, oils and meat (Popkin, Adair and Ng, 2012). Diets of this kind are responsible for one-third of the world's adult population being overweight (Ng *et al.,* 2014) and have been associated with obesity, cardiovascular disease, diabetes, autoimmune diseases and some cancers (Murray *et al.*, 2013). The trend towards simplification of diets is also affecting BFA. The country report of Peru clearly illustrates how recent dietary trends have had a number impacts on biodiversity and *vice versa*:

- The Peruvian population is consuming increasing quantities of carbohydrate in the form of potatoes and rice, most of which is imported (imports of these products grew by 120 percent in the last five years according to the country report). The consumption of quinoa, a grain long considered to be poor people's food, has increased slightly in recent years as a result of its popularization in foreign markets. However, the consumption of traditional tubers such as mashua, oca and olluco continues to decline and these crops are tending to disappear from the highland agroecosystems (at elevations of 3 000 to 4 000 m) where they are normally cultivated. Such agroecosystems are becoming increasingly uniform in terms of their biodiversity.
- A range of products are extracted from Peru's forests by local populations and either consumed locally (e.g. *camu-camu, palmito, cocona*) or exported. Exports of native species from Peru generated, on average, about US$250 million per year in the last decade, approximately 45 percent of which was accounted for by animal species and the rest by plant species. About 80 percent was generated from the export of cultivated plant and animal species, but the export of wild native species has been growing substantially in recent years (e.g. by 130 percent from 2009 to 2012) according to the country report.
- The document entitled *Pesca y seguridad alimentaria: el abastecimiento del pescado fresco en el Perú* (Fish and food security: the supply of fresh fish in Peru) cited in the country report notes important changes in the consumption of fish in Peru, with an increasing share being accounted for by species such as *jurel* (Chilean jack mackerel: *Trachurus murphyi*), *pota* (jumbo flying squid: *Dosidicus gigas*) and *perico* (common dolphinfish: *Coryphaena hippuruses*). Consumption of frozen fish – sold as fresh – is increasing, even in coastal regions. The proportion accounted for by species captured through artisanal, small-scale fishing is declining, as they are replaced by jurel or pota from industrial factory ships or by imported frozen fish sold as fresh.
- According to the same study, growing demand for fish meals and oils has led to an increase in the tonnage of fishing boats used for large-scale capture of anchoveta (*Engraulis ringens*) and other coastal species. This activity is having a serious effect on fish species that are important for human consumption, underpin the livelihoods of artisanal fishers and serve as a major food source for their households. Loss of the species captured in small-scale fisheries leads in turn to more consumption of imported frozen fish at the national level. The report points out that the well-intended objective of increasing the country's per capita fish consumption led to unforeseen ecological problems that are affecting the sustainability of local fisheries.

2.1.2 Biodiversity and ecosystem services

Biodiversity is the basis for the provision of most ecosystem services (e.g. Costanza *et al.,* 1997; Hooper *et al.,* 2005; Ricketts *et al.*, 2008; Blazy *et al.*, 2009; Cunningham *et al.*, 2013). Some of these services result in direct benefits to agricultural production, on-farm or at landscape level (e.g. pollination), while others are beneficial to local communities, to nearby rural and urban areas (e.g. water regulation) or to humanity in general (e.g. carbon sequestration). Sometimes a given component of BFA can serve multiple purposes and benefit multiple users. Two examples from the region can serve to illustrate this:

- Associated and shade trees in coffee gardens provide a range of well-documented ecosystem services, including microclimate regulation, pollination, shade for coffee plants and nutrient cycling (e.g. Babbar and Zak, 1995; Soto-Pinto *et al*., 2000; Vaast *et al.*, 2006; van Oijen *et al.*, 2010; Siles, Harmand and Vaast, 2010) and can also enhance biological pest control. Studies in agroforest coffee gardens in Brazil show that *Inga subnuda*, a tree species that farmers often grow in association with coffee, has extrafloral nectaries in its leaves that represent a local energy source that enhances the activity of natural parasitoids of coffee leaf miners (*Leucoptera coffeella*) and berry borers (*Hypothenemus hampei*) (Rezende *et al.*, 2014). Trees can also provide additional income if they produce fruits or commercial wood. Trees can contribute substantially to reducing soil erosion (e.g. Ataroff and Monasterio, 1997) and thereby reduce the siltation of waterways and prevent the loss of stored soil carbon. Trees themselves can store carbon from the atmosphere and their dead leaves and roots contribute to soil carbon storage. Trees provide habitat for a range of animal species of conservation importance.
- In Latin America, more specifically in the Southern Cone of South America, native grasslands occupy some 700 000 km^2 and, support 65 million head of cattle and the livelihoods of 430 000 rural families in Brazil, Uruguay and Paraguay. These grasslands are home to about 4 000 endemic plant species, including some 800 native grass and 200 legume species (Overbeck *et al.,* 2007) and provide permanent or transitory habitats for a wide range of birds, mammals, reptiles and amphibians (Parera and Kesselman, 2000; Alianza del Pastizal, 2015). They store about 5 percent of the soil carbon of the entire region, control floods and regulate water provision to cities and hydroelectric plants, and constitute the heartland of the local *gaucho* culture (Modernel *et al.*, 2016). Intensification of crop and livestock production in the region threatens the viability of these biodiverse production systems (Baldi and Paruelo, 2008). However, even when individual farmers intensify their production through continuous cropping or sowing ley pastures with exotic species, they always keep part of their farm as native grassland, as this can allow production to continue in dry years or during droughts.

The provision of energy is an important ecosystem service in many parts of the region, particularly in places where rural populations do not have access to electricity or gas for their domestic needs. In many cases, the supply of this service depends almost entirely on associated plant biodiversity. In the dry Altiplano (high plateau) region of Peru, an area dominated by grass steppes with some shrub and short-tree species, the pressure on the natural ecosystem as a result of demand for fuelwood and other fuel plants is very strong. Resinous shrubs such as *tholas* (*Parastrephia lepidophylla*, *Baccharis* spp.) and *yareta* (*Azorella compacta*) and trees such as the local keñua (*Polylepis* spp.) are heavily exploited for fuel. The region also has a number of native grass species that are of high forage value and are becoming rare as a result of overgrazing and other human activities (Orsag, 2009).

2.1.3 Biodiversity and agroecosystem resilience

BFA contributes to the ability of crop and livestock production systems to cope with climatic variability, pest and disease outbreaks and price shocks, thus increasing the resilience of food systems (Gattinger *et al.*, 2012; Kremen and Miles, 2012). Climatic trends for the Latin America and Caribbean region show decreasing average rainfall, increasing temperatures, greater rainfall variability and greater frequency of extreme weather events such as hurricanes (Marengo *et al*., 2014). This will have consequences for land use and for agricultural practices. Resilience is not granted by biodiversity *per se*. Rather, it is mediated by human agency and results from social–ecological interactions that determine the way individual farmers and communities manage BFA (Tittonell, 2014b).

For example, in years of drought or excessive rainfall, biodiverse home gardens are often the only place on the farm from which food can be harvested; these relatively small pieces of land (typically between 0.1 and 0.25 ha) are key to overcoming famines or hunger risk in dry years (Lok, 1998; Torquebiau and Penot, 2006; Pulido *et al.*, 2008). Home gardens are common in the region. They are found on most family-based farms, irrespective of their size, but are most common in the tropical agroecosystems of Central America, the Caribbean and the northern part of South America. They constitute a reservoir of BFA and are given various different names in different parts of the region: traspatio, quinta, solar, huerto casero, jardim da casa, etc. Home gardens and other agroforestry systems have been well documented in the region for more than two decades (Greenberg, 1994). They constitute complex, small-scale polycultures that commonly contain more than 100 species of annual and perennial plant species per field.

The management of these complex agroforestry systems relies on solid ethnobotanical knowledge. For example, the Tzeltal Mayans of Mexico can recognize more than 1 200 species of plants, P'uerepechas more than 900 and Yucatan Mayans some 500 (Altieri, 1991). They represent a repository of genetic resources for cultivated species (e.g. Schneider, 2004) and can host important associated biodiversity. For example, Greenberg (1994) reports the presence of up to 180 bird species that help control insect pests or distribute seeds in a coffee plantation in Mexico. Home gardens are dynamic systems that go through phases of establishment, maintenance and eventual abandonment, with their vegetative associations changing over time. In the Peruvian Amazon, for instance, species such as *Carica papaya* (papaya), *Manihot esculenta* (cassava) and *Ananas comosus* (pineapples) and annual crop species such as maize and rice decrease in frequency as the home garden ages, and perennial species such as *Inga edulis, Pouteria caimito, Genipa Americana, Citrus reticulata* and *Crescentia cujete* come to dominate and shade the garden (Wezel and Ohl, 2005).

2.1.4 Biodiversity and adaptation to climate change

Adaptation to climate change requires genetic diversity and constant selection by rural communities working across climatic gradients. For example, the capacity to explore different ecological niches in the extreme ecosystems of the high Andes depends on a broad base of BFA (Skarbø, 2014). Rich sources of BFA such as these can play a major role in future adaptation to global change. A current example of how BFA hotspots can play a global role is the recent explosion in international demand for quinoa, fuelled by its nutritional properties (Winkel *et al.*, 2012). Examples of genetic resources from the region that may prove useful in efforts to sustain food production in future climates include short-cycle maize varieties adapted to high altitudes in the Andes or to the dry and cold valleys of northern Patagonia. Studies conducted in traditional maize seed systems in eastern Mexico have shown that seed exchanges between farmers take place within a 10 km radius around each farm and across a range of altitudes (Bellon, Hodson and Hellin, 2011). These exchange systems are key to effective local adaptation of maize varieties to climate change.

A literature review of 97 references undertaken by Rossing, Modernel and Tittonell (2014) provides solid evidence from Latin America and the Caribbean that agroecology and other biodiversity-rich production systems provide higher performance in terms of climate change mitigation and adaptation than do conventional systems based on a few crop species and input of non-renewable energy and agrochemicals. Significantly greater carbon sequestration capacity, better energy-use efficiency, greater soil water holding capacity and more resilience to droughts, heavy rainfall and hurricanes were documented (ibid). The resilience of diverse agroecological systems in Central America and the Caribbean following severe physical damage caused by hurricanes has been repeatedly studied. For example, a study of the effects of hurricane Mitch in Nicaragua and Honduras (Holt-Giménez, 2002) found that farms that used agroforestry techniques generally suffered less economic loss than conventional coffee farms. Philpott *et al.* (2008) showed that after hurricane Stan in Chiapas, Mexico, significantly smaller fractions of the land areas of structurally more complex farms were affected by landslides than of those that were less structurally complex.

Table 10 provides a summary of the information provided in the country reports on the use of BFA for coping with climate change, invasive alien species and natural or human-made disasters. It should be noted, however, that many of the plans and initiatives reported do not show very specifically how BFA is contributing to efforts to cope with these problems. A number of countries report, national and regional policies for climate change adaptation and mitigation that have implications for research investments in, for example, climate-smart agriculture or community-based strategies or for the creation of funding or insurance mechanisms. However, none of the reported instruments address, at least not explicitly, the role that biodiversity can play in adaptation and mitigation. The measures reported also include biodiversity conservation initiatives that do not explicitly address links to climate change adaptation and mitigation strategies.

Table 10. Reported policies and initiatives addressing the use of biodiversity for food and agriculture to cope with climate change, invasive alien species and natural or human-made disasters in Latin America and the Caribbean

Country	Description
Use of biodiversity for food and agriculture to adapt to and mitigate climate change	
Ecuador	- Participatory *in situ* conservation of agrobiodiversity - The GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) supported initiative Climate Change, Biodiversity and Sustainable Development, which includes the implementation of the Nagoya Protocol - Global Environment Facility biodiversity-oriented projects implemented by the United Nations Development Programme - The Gloria-Andes initiative, which supports research on biodiversity for adaptation and mitigation Several initiatives led by NGOs
El Salvador	- National Plan on Climate Change emphasizes adaptation strategies in the agriculture, water, infrastructure and public-health sectors, including restoration of critical ecosystems and urban and coastal land-use planning
Grenada	- Implementation of national policy on climate smart agriculture
Jamaica	- C-FISH[1] initiative of the CARIBSAVE Partnership aims to strengthen the resilience of coastal marine ecosystems
Mexico	- Several policies, programmes and legal mechanisms that support climate change adaptation and mitigation, including sustainable agriculture reported, but without explicitly mentioning BFA: Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food, Secretariat of the Environment and Natural Resources; National Institute of Ecology and Climate Change; National Climate Change Strategy; and REDD+ national strategy
Nicaragua	- Reforestation of water sources under the National Crusade for the Reforestation: since 2007, more than 150 000 ha of plantation forest have been established, which represents 70 percent of the initially proposed goal for five years
Panama	- Identification of two local cattle breeds (Guaymí and Guabalá) as a source of biodiversity for adaptation to climate change in the context of smallholder communities
Peru	- Several policies, programmes and legal mechanisms that support climate change adaptation and mitigation reported, but without explicitly mentioning biodiversity for food and agriculture - Regional policies for the conservation and management of biodiversity reported, without explicitly mentioning climate change - The Andean Peoples Integrated Development Plan in the regions of Apurímac, Ayacucho and Huancavelica includes proposals for coping with risk and adapting to and mitigating climate change through supporting community organization and training and through the use of agricultural technologies, but without mentioning the role of biodiversity
Saint Lucia	- National policy on climate change adaptation includes biodiversity issues - Revised national land policy
Use of biodiversity for food and agriculture to control invasive alien species	
Ecuador	- Programme on Bioagriculture for the Galapagos islands aims to reduce the introduction of invasive species through food imports: Galapagos verde 2050 (Green Galapagos 2050)[2] - Reforestation of coastal zones with mangrove species to protect marine habitats
Grenada	- Implementation of strict guidelines for the importation of seed/foods that may have deleterious effects on local biodiversity, thereby mitigating the threat of potential invasive alien species
Jamaica	- Control of exotic lionfish (*Pterois volitans*) through the regional project Mitigating the Threat of Invasive Alien Species in the Insular Caribbean funded by the Global Environment Facility and the United Nations Environment Programme
Mexico	- Legal mechanisms to deal with invasive plants, vertebrates and invertebrates, with emphasis on invasive fish species, but no specific mention of biodiversity for food and agriculture
Panama	- Native entomopathogenic fungi are being tested for use in biological control of coffee borers (*Hypothenemus hampei*)

Table 10 *Cont'd*

Country	Description
Peru	- Identification of native biological control agents for invasive species that act as pests or cause disease - Use of indicator plant species to monitor pest and diseases
Saint Lucia	- Introduction of biological control agents against invasive species - Introduction of resistant cultivars of banana to limit black sigatoka (*Mycosphaerella fijiensis*) in *Musa* spp.
Use of biodiversity for food and agriculture to prevent natural or human-made disasters and/or reduce their effects on livelihoods, food security and nutrition	
Costa Rica	- Reintroduction of beneficial soil micro-organisms to land that has been subject to monocropping - Reforestation with species that provide feed and habitat for honey bees
Ecuador	- Local traditional strategies based on biodiversity management are used to reduce the impact of natural or human-made disasters: a. intraspecific and interspecific diversity in crop parcels; b. family and community seed banks to assist with the restoration of diversity after generalized crop failure; and c. productive diversity – combining sowing dates and spatial arrangements to minimize risks in agroecosystems
Grenada	- Implementation of land-use policies with stricter guidelines on dumping and pollution of marine protected areas to minimize negative effects on livelihoods - Spontaneous use of biodiversity for food and agriculture following natural disasters: for example, increase in the use of local aroids (e.g. dasheen [*Colocasia esculenta*] and tannia [*Xanthosoma sagittifolium*]) or sweet potatoes to replace white potatoes (*Solanum tubersum*), use of local herbal teas and medicinal plants and use of local fish products following Hurricane Ivan in 2004
Jamaica	- C-FISH initiative of the CARIBSAVE Partnership aims to strengthen the resilience of coastal marine ecosystems
Saint Lucia	- Water-quality monitoring system to control coastal water pollution and protect marine (sea moss) biodiversity - Incentives for conversion of farmland to organic agriculture to reduce water pollution and promote soil restoration and conservation

[1] http://www.caribbeanclimate.bz/our-work/c-fish-project-eco-system-based-adaptation
[2] https://www.darwinfoundation.org/en/research/projects/galapagos-verde-2050
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

The contribution of BFA to efforts to cope with and manage the spread of invasive species has been limited, or at least seldom documented (Table 10). Some countries reported on the introduction of exotic biological control agents or the exploration of native biological control agents to regulate pests, weeds and diseases of crops, livestock, forests or species used in aquaculture. The report from Ecuador highlights the Galapagos verde 2050 (Green Galapagos 2050) initiative, which proposes the use of biologically based agriculture to achieve food self-sufficiency on the islands, which have National Park status, and thereby avoid the involuntary introduction of invasive species through food imports from the mainland. The report from Mexico provides a detailed description of the situation of potentially invasive aquatic species used in aquaculture (not shown in Table 10). These species, which are nowadays reproduced under strictly controlled laboratory (nursery) conditions, include carp, rainbow trout, *bagre* (*Ictalurus punctatus*) and *ostión japonés* (*Crassostrea gigas*) (Mendoza and Koleff, 2014). The Mexico report also mentions freshwater invasive species, the *pez diablo or plecos* (*Pterygoplichthys disjunctivus* and *Pterygoplichthys pardalis*) and the freshwater lobster (*Cherax quadricarinatus*), for which commercial capture and utilization is incentivized in order to reduce their populations.

2.1.5 Ecosystem, landscape and seascape approaches

Reported examples of ecosystem, landscape and seascape approaches[6] in the region are presented in Table 11. Seascape approaches to the management of marine reserves and sustainable-fishing

[6] The ecosystem approach concept is generally understood to encompass the management of human activities, based on the best understanding of the ecological interactions and processes, so as to ensure that ecosystem structure and functions are sustained for the benefit of present and future generations. Ecosystem approaches include the Convention on Biological Diversity's Ecosystem Approach, Integrated Land Use Planning, Integrated Water Resource Management, Sustainable Forest Management, Code of Conduct for Responsible Fisheries, Ecosystem approach to fisheries management, etc. According to the World Bank "a landscape approach" means "taking both a geographical and socio-economic approach to managing the land, water and forest resources that form the foundation – the natural capital – for meeting our goals of food security and inclusive green growth. … By taking into account the inter-actions between these core elements of natural capital and the ecosystem services they produce, rather than considering them in isolation from one another, we are better able to maximize productivity, improve livelihoods, and reduce negative environmental impacts" (World Bank, 2012).

schemes (Box 2) and landscape approaches to the management of forest resources and sustainable forestry were the most commonly reported measures of this kind. Landscape approaches in agricultural (crop and livestock) systems were less commonly reported.

Box 2. Ecosystem approach to fisheries management in Saint Lucia

An ecosystem approach to fisheries management and a code of conduct on sustainable fisheries adopted in Saint Lucia led to fishers' widespread compliance with the implementation of measures to improve management and development within the industry. This led to increased biomass of fishery species, greater marine biodiversity and enhancements to marine ecosystems. However, achieving these results required a long series of actions and political investments. Specific actions taken to ensure adoption included:

- signing the Caribbean Regional Fisheries Mechanism 2010 Castries (St. Lucia) Declaration on Illegal, Unreported or Unregulated Fishing;
- accession to the 2009 FAO Port State Measures Agreement to Prevent, Deter and Eliminate Illegal, Unreported or Unregulated Fishing (Saint Lucia officially acceded on 17 June 2016);
- 2015 St. George's Declaration on the Conservation, Management and Sustainable Use of the Caribbean Spiny Lobster (Panulirus argus);
- endorsement of the Draft Management Plan for Blackfin Tuna;
- endorsement of the Draft Management Plan for Fish Aggregating Device Fishery;
- endorsement of the Management Plan for Queen Conch;
- promotion of consultative processes among fishers and other stakeholders in every aspect of fisheries planning, development, management, conservation and sustainable utilization;
- expansion of the marine protected areas programme as a tool to enhance fisheries management;
- adoption of the Caribbean Regional Fisheries Mechanism Regional Management Plan for Flying Fish Fishery; and
- promotion of the strengthening of fisher folk organizations at local and national levels.

Lesson learned

Engaging in meaningful consultation and building partnerships with fishers and other stakeholders, including development agencies and partners at the regional and international levels, proved key to strengthening fisheries management and development.

Source: Country report of Saint Lucia.

Table 11. Reported examples of initiatives that use an ecosystem/landscape/seascape approach in Latin America and the Caribbean

Country	Ecosystem/landscape/seascape approach(es)
Ecuador	- Programme known as Forest Partner, which uses an ecosystem approach to positively influence the provision of ecosystem services of *páramos* (highland moorlands), forests (temperate, subtropical and tropical) and mangroves, with positive impacts on biodiversity conservation - Small-donations programme to strengthen biodiversity-rich campesino systems though revalorization of traditional knowledge
El Salvador	- Several wetland ecosystems fall under Ramsar Convention protection schemes: (i) Bahía de Jiquilisco; (ii) Laguna El Jocotal; (iii) Laguna de Olomega; (iv) Complejo de Jaltepeque; (v) Complejo de Guija; (vi) Embalse Cerrón Grande
Grenada	- Development of apiculture to support pollination, with a positive impact on productivity, especially on exotic-fruit production - Pest and disease regulation, especially through integrated pest management and the imposition of strict guidelines on quarantine regulations to curb the spread and incidence of invasive alien species - Sustainable forestry management to ensure sustainable supply of water, support biodiversity for food and agriculture, mitigate drought and soil erosion, etc. - Responsible fishing (management of stocks through implementation of open and closed fishing seasons, marine protected areas, etc.) to help maintain sustainable fisheries stocks - Implementation of forestry policy, including the development and implementation of protected areas system plans, with specific site-management plans in critical forest areas, such as Grand Etang, Mount Hartman and Annadale, and reforestation of degraded areas

Table 11 *Cont'd*

Country	Ecosystem/landscape/seascape approach(es)
Guyana	- Swamp empoldering for cultivation in coastal and near-coastal areas to retain water and nutrients obtained from the application of livestock (poultry) manure; this is the standard practice for swamp-eddo cultivation in these areas - Use of turtle-excluding devices and bycatch reduction devices in fishing operations to manage and minimize impact on the structure, productivity, function and biological diversity of the ecosystem - Broadening stakeholders' participation in management, data collection, knowledge building, option analysis, decision-making and implementation in fisheries - Introduction of an annual seven-week closed season during which the seabob (*Xiphopenaeus kroyeri*) fishery is closed to trawling to allow regeneration of the stock; the introduction of the closed season was prompted by a drastic reduction in the catch and in the size of the seabob
Jamaica	- The Inter-America Institute for Cooperation on Agriculture engaged EcoReefs to create reef-fish habitat in the Bluefield's Bay and Montego Bay fish sanctuaries; 350 EcoReefs modules were installed at each site, and staghorn corals (*Acropora cervicornis*) were transplanted at the Montego Bay site; the project was sponsored through the Canadian International Development Agency/Jamaican Ministry of Agriculture and Fisheries/ Inter-American Institute for Cooperation on Agriculture Improving Jamaica's Agricultural Productivity Project and was completed in August 2011 - The Government of Jamaica's Adaptation Fund Programme for Building Resilience of the Agricultural Sector and Coastal Areas
Mexico	- Conduct Code on Responsible Fishing/Ecosystem Approach for Planning Self-Recruiting Capture Fishery and for Fed Aquaculture
Nicaragua	- Ecosystems approach used in several national instruments, including the General Environmental Law,[1] Law on Water Management,[2] Law for the Promotion of Agroecology and Organic Agriculture[3] and Forest Law[4]
Panama	- Ecosystems approaches used in: • grassland-based livestock systems – up to 90 percent of the livestock keepers use living hedgerows and keep trees in the landscape; • Sustainable Forest Management Plan (2000–2008); • national strategies for maritime and aquatic resource management (Caribbean lobster, cambute or marine snail, sea cumbers, polychaetes, sharks, etc.); • special management and conservation of marine zones (Playa La Marinera, Archipelago de Las Perlas, Bahía de los Delfines in Bocas del Toro and the Golfo de San Miguel in Darién) and the special coastal management zone of Sur de Azuero, for the protection of sea turtles; • conservation plan for Bahía de Panamá wetlands, including 21 percent of the total area of mangroves on the Pacific coast; and • research on several integrated pest management practices, but currently limited adoption
Peru	- Since 1995, the Dutch-funded Project for the Integral Management and Use of the Mangroves of the Northwestern Coast of Peru has helped to strengthen the administration and management of the area, consolidating users' organizations for the sustainable development of local communities and contributing to better understanding of local problems and to the participatory planning of activities - The Ministry of the Environment is undertaking a study on the design of a scheme for payment for hydrological environmental services in the Río Cañete watershed, the aim of which will be to provide for the sustainable management of water resources while contributing to the preservation of hydrological ecosystems services to society - In the aquaculture and fisheries sectors, some private companies have adopted ecosystem approaches to resource management: for example, the company Acuapesca has obtained IFS (International Food Standards) certification - The Global Environment Facility Project Humboldt 611 addresses the management of marine resources in the great Humboldt Current ecosystem - The National Strategy for Biological Diversity proposal of 2014 and its plan of action adopted an ecosystems approach that involves strong participation of local communities - In 2014, the Ministry of Environment approved the Law on Mechanisms of Retribution for Ecosystem Services[5] - Use of the ecosystems approach in a binational project on environmental assessment in the Lake Titicaca and Desaguadero river watershed (2004–2005) - Use of the ecosystems approach in an environmental assessment of the Chunta Huayjo watershed in Arequipa (Malpartida *et al.*, 2007)

[1] Ley No. 217 – Ley general del medio ambiente y los recursos naturales con sus reformas incorporadas. Aprobada el 17 de enero del 2014. Publicada en La Gaceta N° 20 del 31 de enero del 2014 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/c/LEX-FAOC138661/).
[2] Ley No. 620 – Ley general de aguas nacionales. La Gaceta Nº 169, 4 de septiembre de 2007, págs. 5664–5682 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC074427).
[3] Ley Nº 8.542 – Ley de desarrollo, promoción y fomento de la actividad agropecuaria orgánica. La Gaceta Nº 206, 27 de octubre de 2006, págs. 2–6 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC067072).
[4] Ley Nº 462 – Ley de conservación, fomento y desarrollo sostenible del sector forestal. La Gaceta Nº 168, 4 de septiembre de 2003 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC043694).
[5] Ley Nº 30.215 – Ley de mecanismos de retribución por servicios ecosistémicos. El Peruano, 29 de junio de 2014 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC135640).
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

2.1.6 Traditional knowledge

The small-donations programme implemented in Ecuador supports community-based initiatives aimed at strengthening traditional – in some cases ancestral – approaches to the management of BFA through the implementation of agroecological practices. The programme aims to maintain and restore agrobiodiversity, recover "old" or forgotten genetic resources and manage soil biodiversity without the use of agrochemicals. The objective is to achieve local food sovereignty by combining traditional and more recent knowledge on the functioning of ecosystems to promote sustainable and economically viable agroecosystems that are able to stop the expansion of the agricultural frontier into fragile ecosystems. Cooperation and collective action at community level are actively promoted. Also in Ecuador, the direct participation of artisanal fishers as taxonomists and ecologists makes a key contribution to the design and implementation of plans for the conservation of aquatic resources, territorial planning, fisheries management and the identification of research needs (Begossi *et al.*, 2008). Costa Rica's small donations programme is described in Box 3.

Costa Rica's Law on Biodiversity[7] addresses the protection of traditional knowledge systems associated with biodiversity in general. Costa Rica's indigenous population consists of eight groups, inhabiting 24 territories throughout the country. Their knowledge and traditional practices associated with biodiversity management include medicinal practices, hunting and fishing, handicrafts and management of crops (e.g. maize, beans and tubers) and various livestock species. A similar situation was reported by Peru, where a national law (dating from 2002)[8] protects indigenous peoples' traditional knowledge of biological resources. Domestication is one of the aspects of traditional knowledge protected by the law, which also provides the framework for studies on propagation systems, photochemical studies of medicinal plants and pigments, and studies on the nutritional value of edible wild species.

"Chaku", the method used in the Andes to capture vicuñas to obtain their wool, is based on ancestral techniques used by the Incas and is protected by the aforementioned law. Dehydration of fish and its conservation in salt is another important protected traditional food-processing practice that has outlived other conservation technologies. There is also a countrywide initiative to establish agrobiodiversity conservation areas, as well as projects on the revalorization of *campesino* technologies in the Andes.

Box 3. Costa Rica's small donations programme

For more than 20 years, the small-donations programme of the Global Environmental Fund (GEF) in Costa Rica, supported by the United Nations Development Programme, has been supporting community-led initiatives that support behavioural changes and the implementation of production activities that favour biodiversity, climate change adaptation and soil conservation. During the last phase, 120 community initiatives were supported in the Río Jesús María watershed, one of the country's most degraded zones, where local communities showed high levels of interest, engagement and action.

As of 2016, the programme expects to expand to another 240 farmers in three new communities, and to have similar impact in 13 communities in the neighbouring Barrancas watershed, engaging 260 farmers and local water-management associations. The objective is to integrate the efforts in the two watersheds, which share the important biological corridor of Montes de Aguacate. These pilot initiatives are expected to provide important experience for the dissemination of the approach countrywide under the VI Operational Phase of GEF.

Source: Country report of Costa Rica.

[7] Ley N° 7788 del 30/04/1998 de biodiversidad (modificada por última vez por la Ley N° 8686 del 21 de noviembre de 2008) (available in Spanish at http://www.wipo.int/wipolex/es/details.jsp?id=11314).

[8] Ley N° 27811, del 24 de julio de 2002, mediante la cual se establece el régimen de protección de los conocimientos colectivos de los pueblos indígenas vinculados a los recursos biológicos (available, in Spanish, at http://www.wipo.int/wipolex/es/details.jsp?id=3420).

In Grenada, there are programmes that aim to strengthen the use of traditional knowledge associated with BFA and wild foods, including through the use of holders of traditional knowledge in training activities coordinated by the Ministry of Agriculture and the provision of technical and financial support to communities endowed with traditional knowledge. Popularization of wild foods and traditional knowledge is facilitated through the participation of communities associated with these resources in national exhibitions, such as the FAO-sanctioned World Food Day and national food festivals, and promoting the development of recipes that use traditional knowledge and wild foods.

One way to protect and strengthen traditional knowledge is through policies that regulate their use and create legal mechanisms to protect intellectual property rights. The Government of Panama has taken several steps in this direction including through the promulgation of a national law on intellectual property rights[9] that includes indigenous knowledge and through sui generis measures to protect all indigenous rights, including practices and knowledge related to indigenous medicines. At a more practical level, Panama's Institute for Agriculture and Livestock Research engaged with indigenous communities of the Ngäbe Buglé region in an effort to preserve and strengthen their local agricultural knowledge by providing support in institutional capacity building and in the establishment of a local science and technology system.

2.1.7 Needs and priorities

Reported needs and priorities related to the sustainable use of BFA, and in particular of associated biodiversity and wild foods, are listed in Table 12. Research needs and knowledge gaps related to traditional forms of sustainable use of biodiversity were noted by most countries, as well as the need for capacity development and for strengthening material and human resources. Institutional capacities and institutional innovation, as well as dissemination of knowledge among policy-makers and decision-makers, were also frequently mentioned. Most notably, several countries indicated the need for institutional changes that consolidate BFA-related policies and actions, the responsibility for which is now typically spread across various ministries (agriculture, environment, culture, natural resources, fisheries, development, etc.) within the respective country. This creates unnecessary institutional islands, miscommunication and some degree of competition for resources and responsibilities.

Table 12. Reported needs and priorities for the sustainable use of biodiversity for food and agriculture in Latin America and the Caribbean

Country	Needs and priorities
Bahamas	- Promote effective participation of small states in the protection and preservation of genetic diversity at the global level - Improve the availability of trained personnel and financial resources to implement inventories and conservation efforts
Ecuador	- Improve institutional capacity to widen knowledge about soil micro-organism biodiversity and genetic resources, to collect and inventory them and to promote their possible sustainable use in agriculture - Conduct specific studies on the loss and genetic erosion of traditional species and wild foods - Develop a legal framework to regulate the roles and competencies of different institutions with respect to the management of biodiversity and genetic resources in the context of future climate change scenarios (especially for marine resources) - Invest in long-term research programmes on the sustainable use of biodiversity for food and agriculture - Develop and implement a basic training curriculum on biodiversity for politicians and decision-makers
El Salvador	- Develop capacities on the sustainable use of biodiversity for food and agriculture - Promote *in situ* conservation of genetic resources, complemented by *ex situ* conservation - Strengthen human resources - Prepare a compilation of traditional knowledge on the sustainable use of BFA

[9] Ley 20 de 26 de junio de 2000. Del régimen especial de propiedad intelectual sobre los derechos colectivos de los pueblos indígenas, para la protección y defensa de su identidad cultural y de sus conocimientos tradicionales, y se dictan otras disposiciones. Gaceta Oficial No. 24,083 of 27 June 2000 (available, in Spanish, at http://www.wipo.int/wipolex/es/details.jsp?id=3397).

Table 12 *Cont'd*

Country	Needs and priorities
Grenada	- Strengthen research and development activities geared towards the sustainable use of biodiversity for food and agriculture - Intensify the adoption of climate-smart approaches - Develop public-awareness programmes geared at educating the public on issues related to biodiversity for food and agriculture - Develop more robust policy frameworks to minimize the negative drivers of change affecting biodiversity - Implement sustainable land-management practices and programmes that target agroforestry and reforestation - Increase the availability of information and knowledge on the role of biodiversity in supporting food-production systems
Guyana	- Implement national-level diagnosis - Determine the genetic characterization and the overall status of Guyana's animal, aquatic, plant and forest genetic resources - Increase the technical capacities of staff within key organizations - Improve awareness by incorporating training on biodiversity into the curriculum of agricultural undergraduate and postgraduate programmes at the University of Guyana - Disseminate information to farmers through training/outreach sessions for farmers across Guyana and radio and television education programmes such as GuySuCo's Round Up TV Programme - Develop and produce technical-information packages for farmers that can be included in handbooks and manuals distributed by various organizations and utilized by the agricultural extension services
Jamaica	- Provide critical budgetary support and funding to implement programmes related to sustainable use - Promote public awareness and education of fishers and fisher folk
Mexico	- Create solid, long-term interinstitutional coordination on cross-cutting issues related to biodiversity for food and agriculture - Allocate more resources and build institutional capacities - Develop instruments (political, institutional and technological) to implement ecosystems approaches to the use of biodiversity for food and agriculture in agroecosystems - Promote greater involvement of the primary production sector through policies that aim to bring production and extraction systems together and support the sustainable use of biodiversity - Implementing the above-listed priorities requires revision of national laws such as the General - Law of Ecological Equilibrium and Environmental Protection[1] and the Law of Sustainable Rural Development[2]
Nicaragua	- Promote silvopastoral and agroforestry systems - Strengthen the reforestation plan for rural and urban areas - Promote the establishment of forest plantations through the Forest Fund - Strengthen forestry seed banks - Promote the sustainable use of wild foods, particularly through rearing systems for animal species that are in high demand
Panama	- Develop a national policy on biodiversity for food and agriculture - Systematize the information generated to estimate the impacts of programmes and/or projects implemented
Peru	- Implement studies on the sustainable use of biodiversity for food and agriculture and associated biodiversity - Expand investment in basic biodiversity research - Implement educational policies in zones of high agrobiodiversity and provide incentives for the youth to stay in rural areas - Develop policies to regulate the impact of mining activities on agrobiodiversity through compensatory payments to avoid the abandonment of rural areas in mining regions - Develop technological innovation policies that consider and promote the integration of traditional and scientific knowledge - Improve the availability of information on the functioning of marine ecosystems, particularly with regard to invasive algae species - Implement studies on the effects of climate change on biodiversity dynamics and distribution - Implement studies and develop expertise on the effects of climate change on forest biodiversity patterns - Improve material and human resources and capacity-building
Saint Lucia	- Study and report on variability among the varieties and species of wild foods in different ecosystems
Suriname	- Improve the generation of knowledge in the field of sustainable use of biodiversity for food and the transfer of this knowledge - Increase investment in capacity building - Address the fact that the policy framework is spread over various ministries

[1] Ley general de equilibrio ecológico y de protección al ambiente. Diario Oficial de la Federación, 28 de enero de 1988 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC005750).

[2] Ley de desarrollo rural sustentable. Diario Oficial de la Federación, 7 de diciembre de 2001, págs. 132–174 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/?details=LEX-FAOC050486).

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

2.2 CONSERVATION

2.2.1 *In situ* conservation

Reporting countries that have *in situ* conservation programmes in place for associated biodiversity and wild food species include Ecuador, El Salvador, Grenada, Jamaica, Mexico, Nicaragua, Panama and Peru. The species conserved are mostly plants and vertebrates, with some examples of invertebrates and micro-organisms. In most cases, the conserved species represent associated biodiversity. Many of the reported cases of *in situ* conservation refer to ecosystems, landscapes, seascapes or watersheds that include a broad range of life forms. Some such sites, for example marine reserves in coastal areas, serve as *in situ* conservation sites for associated biodiversity and wild food species. However, some countries reported conservation areas (e.g. nature reserves) that may not – strictly speaking – host associated biodiversity or wild foods *per se* or were not created with the objective of conserving these categories of biodiversity. Several countries reported examples that pertain to BFA, but not strictly to associated biodiversity or wild food species.

Reported examples of marine protection reserves and fishing restriction zones for seascape regeneration and *in situ* conservation from Saint Lucia (Box 2) and Grenada are discussed above. Examples from Jamaica are presented in Box 4. *In situ* conservation of BFA and associated biodiversity has been practised for centuries in countries such as Peru, particularly in its Andean zone. Since 1996, several *in situ* conservation projects have been launched, including the *In Situ* Conservation of Native Crops and their Wild Relatives Project, implemented between 2001 and 2006 by the national agricultural research organization and four NGOs (Asociación ARARIWA, Centro de Servicios Agrarios, Proyecto de Alternativas Tecnológicas Campesinas and Coordinadora de Ciencia y Tecnología Andina) with the aim of conserving biodiversity in farmers' fields, protecting wild relatives of cultivated crops, creating awareness of ecological, cultural and nutritive values, strengthening community organization, developing and consolidating markets, developing supportive policies and designing an information and monitoring system. This initiative targeted 11 native crop species, 19 crop associations and involved 154 communities in 53 districts.

Mexico presented an extensive report on *in situ* conservation initiatives for associated biodiversity, wild foods and other components of BFA. Examples include 25 community seed banks that can be used to address climatic contingencies via the donation of seeds to farmers. Table 13 provides examples of *in situ* conservation and monitoring of wild relatives and landraces of cultivated species such as jatropha, jojoba and cotton. Several initiatives, in various parts of the country, are reportedly targeting the conservation of at least 85 wild food species of plants,

Box 4. Jamaica's fish sanctuaries and monitoring systems

The Boscobel Sanctuary is a protected area off the north coast of Jamaica. It is part of the Sandals Foundation's Marine Plan, which includes a commitment to the management of marine sanctuaries, placement of marker buoys in designated areas, monitoring of reefs and fish populations, and working alongside the Jamaican Government, fisher folk and community members to ensure the country's citizens are aware of the benefits of marine protected areas. Since the launch of the Boscobel Sanctuary in 2009, and subsequently its declaration as a Special Fishery Conservation Area in 2012, several surveys have shown signs of new coral growth and an increase in fish population.

The Conch Abundance Survey Programme, implemented every three to five years on the 8 000 km^2 Pedro Bank, the main fishing ground of the queen conch, establishes research transects on the seafloor, at depths ranging from 10 m to 30 m, at 80 sites. Counts are made within these transects and other critical ecosystem parameters are recorded in order to determine the biomass and stock size. The data are used to establish a national quota for the subsequent fishing season. Between surveys, catch and effort data based on landings are used to determine annual quotas.

Source: Adapted from the country report of Jamaica.

Table 13. Reported examples of *in situ* conservation initiatives for wild relatives and landraces of cultivated plant species in Mexico

In situ conservation initiative	Target species	Objective
Jatropha species at Tehuacan-Cuicatlan Ecological Reserve	*Jatropha rzedowskii* *J. oaxacana* *J. neopauciflora* *J. ciliata* *J. rufescens*	Assessment and conservation of the genetic diversity of wild jatropha species
Jatropha species at Itsmo de Tehantepec	*Jacquemontia oaxacana* *Jatropha pseudocurcas* *J. sympetala* *J. alamanii* *J. malacophylla* *J. gossypiifolia* *J. tehuantepecana* *J. curcas*	Inventory of jatropha species and assessment of their diversity, distribution, density and frequency
Jojoba species at the El Vizcaíno Biosphere Reserve, Baja California Sur, and the Valle de Los Cirios Flora and Fauna Protected Area, municipality of Ensenada, Baja California, and in Sonora	*Simmondsia chinensis*	Study of the genetic diversity of jojoba populations
Ornamental tree “elephant foot” in San Francisco Uninajab, municipality of Comitán de Domínguez, Chiapas	*Beaucarnea goldmanii*	Population studies to establish and register a management scheme
Cotton in Morelos, Oaxaca, Nayarit and Guerrero States	*Gossypium hirsutum*	Collection of ethnobotanic information on the distribution of cultivated and wild cotton and its use by local populations

Source: Country report of Mexico.

vertebrates, invertebrates and micro-organisms. Several marine fishing refuge zones along the country’s coastline protect a total of 163 species of fish, crustaceans, conches and sea turtles. A total of 16 freshwater fishing refuge zones have been established to protect the eggs and juvenile stages of freshwater fish species, mostly in dammed lakes.

Regional initiatives reported for the *in situ* conservation of biodiversity and wild food species include the C-Fish Project devised by the environmental not-for-profit CARIBSAVE Partnership. The project aims to strengthen community-based fish sanctuaries and marine protected areas in five countries across the Caribbean – Dominica, Grenada, Jamaica, Saint Lucia and Saint Vincent and the Grenadines – with the objective of generating significant environmental, social and economic benefits in fields ranging from sustainable fisheries to tourism and natural coastal defences. These efforts reflect a growing international focus on ecosystem-based adaptation to climate change and cost-effective strategies for small island developing states, where strengthening the resilience and productivity of coastal ecosystems can reduce the impacts of climate change.

2.2.2 *Ex situ* conservation

Ex situ conservation facilities were reported by Costa Rica, Ecuador, El Salvador, Mexico, Peru, Grenada, Jamaica, Panama and Nicaragua. These facilities provide for the *ex situ* conservation of 25 plant species, 16 terrestrial vertebrate species, 10 fungi species (including 8 mycorrhizas), 10 bacterial species, 8 aquatic vertebrate species and 8 invertebrate species of associated biodiversity and wild foods.

Other examples of *ex situ* conservation of associated biodiversity and wild food species and other categories of biodiversity also reported. The report from Guyana, for example, mentions the *ex situ* conservation of the micro-organisms *Bacillus* sp., *Pseudomonas* sp. and *Beauveria bassiana* for the control fungal diseases, and of the arthropods *Telenomus* sp. (a wasp) and *Coccinella septempunctata* (a ladybird beetle) for the control of and rice pests (paddy bugs

[*Oebalus poecilus*]). El Salvador and Mexico reported *ex situ* conservation facilities for various types of BFA, including associated biodiversity and wild food species. Costa Rica reported invertebrate collections consisting of 3 577 274 specimens (extracts and dead organisms), of which 66 900 constitute an inventory of arthropod biodiversity. Grenada reported on incipient *ex situ* conservation initiatives for germplasm of high-value species such as spices, exotic tropical fruits, cut flowers and roots and tubers.

The objectives of the reported *ex situ* conservation initiatives include inventory and research, conservation and reproduction, genetic improvement and certified seed production, maintenance of resources for potential use in future production systems, repopulation, dissemination and commercial use. Objectives less frequently mentioned included production of feed for aquaculture fish and fixation of atmospheric nitrogen by bacteria. Peru reported the *ex situ* conservation of native domestic camelids (llamas and alpacas) for reproduction purposes at the Quimsachata site and for breeding at the Centro de Investigación La Raya in Puno. Peru also reported the conservation of butterflies for reproduction purposes. In Jamaica, the Tissue Culture Unit of the Scientific Research Council was established to preserve rare, endangered and economically important species, while the Tissue Culture Unit of the Research and Development Division of the Ministry of Agriculture and Fisheries has cultures of 28 varieties of local sweet potato types and 11 varieties of cassava.

2.2.3 Needs and priorities

Reported needs and priorities in terms of the conservation of BFA, and in particular associated biodiversity and wild food species, are listed in Table 14. In several cases, these priorities do not differ much from those identified for sustainable use (Table 12). The two major needs and priorities that stand out, as they were mentioned virtually by all countries, are:

- generating knowledge and information pertinent to conservation; and
- addressing current limitations in terms of funding and the availability of qualified human resources.

Baseline field research to assess the current status of BFA was mentioned as a prerequisite for conservation plans. Other frequently mentioned priorities included strengthening political support, developing relevant policies and legal frameworks, greater dissemination of knowledge, and expansion of ongoing conservation initiatives. Also mentioned was the need for greater integration of biodiversity-conservation and agricultural-productivity agendas. The need for better information about illegal practices, for example in the case of fishing activities, and their impact on biodiversity conservation was also highlighted.

Table 14. Reported needs and priorities for the conservation of biodiversity for food and agriculture in Latin America and the Caribbean

Country	Needs and priorities
Bahamas	- Organize conservation efforts targeting landraces of traditional crops affected by the introduction of high-yielding improved varieties and hybrids
	- Provide incentives to reduce out-migration of custodians of traditional varieties from rural areas
Costa Rica	- Generate information on associated biodiversity and wild food species and their relation to climate change, ecosystem services, natural disasters and invasive species
	- Conduct a national assessment on biodiversity for food and agriculture
	- Improve integration and coordination between the private and public sectors
	- Create a National System for Agrobiodiversity
	- Provide more financial and political support
	- Develop new protocols on biodiversity for food and agriculture
	- Further explore the potential of renewable energy within agroecosystems
	- Treat biodiversity as an “input” to agricultural production, water conservation, forest management and rural poverty reduction
	- Improve knowledge of indigenous management of biodiversity
	- Assess the situation (status and trends) of wild pollinators

Table 14 *Cont'd*

Country	Needs and priorities
Ecuador	- Clarify the roles and competences of institutions - Address financial limitations and knowledge gaps; more research is required on techniques for *ex situ* conservation in seed banks (regeneration, refreshment, etc.) - Improve knowledge of forest genetic resources, particularly those used as food and for other purposes - Widen information and knowledge on genetic resources in general through multidisciplinary research programmes with enough funding and duration to support decision-making on conservation - Improve cartographic information to detect destruction and fragmentation of habitats - Improve information on aquaculture genetic resources (current information is fragmented and dispersed) - Improve detailed characterization of the country's ecosystems and the dynamics of drivers affecting them - Develop regulations and deploy resources to control unsustainable fishing activities, by-capture, and the use of illegal methods and practices (capture of small-sized fish) - Obtain information on sea pollution with residues of fishing material, motor oil spills, etc., and on transgression of conservation zones or periods, that affect sea biodiversity and coastal livelihoods
El Salvador	- Improve management of *ex situ* conservation initiatives - Develop capacities on new methodologies for conservation - Document current collections of certified and native seeds, of bovine, poultry and porcine livestock species, of honey bees and of fish, crustacean and mollusc species - Assess the representativeness of current collections and identify duplicates - Assess the impact of facilitated access to biodiversity on national policies for the conservation and management of genetic resources - Rationalize current collections through regional and international cooperation and sharing of conservation facilities to: • share the costs of conservation • optimize germplasm maintenance practices • fill gaps in the collections • establish systems for safety duplication • promote global efforts for regeneration of germplasm - Implement research into the development of less-expensive conservation technologies
Grenada	- Deploy more resources for the conservation of biodiversity for food and agriculture - Develop more-effective policies for the conservation of biodiversity for food and agriculture and wild food species - Identify priority needs for the conservation of biodiversity for food and agriculture and wild food species - Prioritize conservation efforts for biodiversity for food and agriculture and wild food species - Collaborate with regional and subregional countries in developing programmes aimed at enhancing the conservation of biodiversity for food and agriculture and wild food species
Mexico	- Address the lack of precise and regularly updated cartographic information and of programmes oriented to the sustainable use and conservation of biodiversity for food and agriculture - Ensure coordination of research efforts across institutions and better integration of existing isolated knowledge on biodiversity for food and agriculture - Disseminate knowledge and raise awareness on biodiversity for food and agriculture in society - Obtain information on the current status and trends of biodiversity for food and agriculture - Address current limitations in terms of financial and qualified human resources - Generate field data for the characterization and evaluation of native species - Improve the dissemination of knowledge about existing laws and regulations among forest managers - Develop policies and laws to regulate the sustainable use and conservation of biodiversity for food and agriculture - Increase the interest of political actors in themes of relevance to biodiversity for food and agriculture - Develop more robust environmental indicators - Strengthen current programmes that have delivered successful outcomes in terms of biodiversity conservation
Nicaragua	- Support associated biodiversity through better infrastructure, technology and qualified human resources for the conservation, diversification and production of marine and aquatic resources - Develop programmes to rescue and conserve endangered components of agrobiodiversity (e.g. Teocintle maize, ojoche [*Brosimum alicastrum*], pochote [*Ceiba aesculifolia*]) - Implement actions for the *in situ* and *ex situ* conservation of associated biodiversity

Table 14 *Cont'd*

Country	Needs and priorities
Peru	- Implement research on conservation methods for biodiversity for food and agriculture - Implement research on the current status of biodiversity for food and agriculture (e.g. research results on potato biodiversity are now in hands of the International Potato Centre and not of the Government of Peru) - Provide financial and political support for basic research and collection of information - Invest in qualified human capital and institutional capacities for biodiversity conservation
Saint Lucia	- Conduct baseline research and information of the current status of biodiversity for food and agriculture and associated ecosystem services - Conduct studies on variability in wild food species and better characterize associated biodiversity
Suriname	- Generate knowledge on the management of genetic resources, associated biodiversity and ecosystem services - Address current limitations in terms of financial resources and qualified human resources

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

2.3 ACCESS AND EXCHANGE

Measures facilitating access to the various components of BFA usually vary according to the intended use of the resource (e.g. any use, research and development, or commercial use). Examples of possible measures include the need to obtain prior informed consent, share benefits based on mutually agreed terms and have special considerations in place for access to resources held by indigenous peoples and local communities. Table 15 summarizes information provided in the country reports about measures to regulate access and ensure the fair sharing of benefits arising from the utilization of BFA. The reporting was generally not very extensive. The need for prior informed consent as reported by some countries applies both to genetic resources for food and agriculture and to associated biodiversity and wild foods.

Table 15. Reported needs and priorities for the assessment and monitoring of biodiversity for food and agriculture in Latin America and the Caribbean

Components of biodiversity for food and agriculture	Description of measures
Plant, animal, forest and aquatic genetic resources for food and agriculture	
Plant genetic resources for food and agriculture	- Prior informed consent required for access to aquatic and terrestrial cultivated plants - Work in progress to adjust to the Nagoya Protocol (Mexico) - Access to genetic resources, biochemical compounds and indigenous knowledge on their management requires prior informed consent, but participatory work is ongoing with communities to regulate access and sharing (Costa Rica) - Access to material under *ex situ* conservation is regulated and requires permission, except in the case of exchanges between local communities (Costa Rica) - Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization are followed within the framework of the International Treaty on Plant Genetic Resources for Food and Agriculture (Costa Rica) - Guyana's National Policy on Access and Benefit Sharing addresses: • users' obligation to seek free and prior informed consent of providers and/or owners; • identification of the basic requirements for mutually agreed terms; • definition of the main roles and responsibilities of users and providers/owners; • the importance of stakeholder involvement; and • institutional arrangements for monitoring compliance
Animal genetic resources for food and agriculture	- Regulations on management, conservation and use of vicuña populations, including community monitoring systems (Plurinational State of Bolivia) - Authorization to shear live wild vicuñas by local Andean communities
Forest genetic resources	- Not specifically reported unless to indicate that provisions are similar to those for other plant genetic resources and biochemical compounds

Table 15 *Cont'd*

Components of biodiversity for food and agriculture	Description of measures
Aquatic genetic resources for food and agriculture	- National Federation of Artisanal Fishery Cooperatives claim fair access to fishing resources through prior informed consent/access and benefit-sharing mechanisms - The Ecuadorian Ministry of Environment has addressed the regulation of access to aquatic and amphibian resources by creating the National Biodiversity Institute (Instituto Nacional de Biodiversidad – INB)[1] - INB is to join the Consortium for the Barcode of Life initiative[2]
Associated biodiversity	
Micro-organisms	- Prior informed consent and sharing of benefit required (Costa Rica) - Otherwise, not specifically reported unless to indicate that provisions are similar to those for other genetic resources and biochemical compounds
Invertebrates	- Prior informed consent and sharing of benefit required (Costa Rica) - Otherwise, not specifically reported unless to indicate that provisions are similar to those for other genetic resources and biochemical compounds
Vertebrates	- Prior informed consent and sharing of benefit required (Costa Rica) - Otherwise, not specifically reported unless to indicate that provisions are similar to those for other genetic resources and biochemical compounds
Plants	- Prior informed consent and sharing of benefit required (Costa Rica) - Otherwise, not specifically reported unless to indicate that provisions are similar to those for other genetic resources and biochemical compounds
Wild foods	
Wild plants	- Not specifically reported unless to indicate that provisions are similar to those for plant, animal and aquaculture genetic resources, biochemical compounds and associated biodiversity
Wild land animals	- Not specifically reported unless to indicate that provisions are similar to those for plant, animal and aquaculture genetic resources, biochemical compounds and associated biodiversity
Wild fish	- Not specifically reported unless to indicate that provisions are similar to those for plant, animal and aquaculture genetic resources, biochemical compounds and associated biodiversity

[1] Decreto Ejecutivo No. 245 de 24 de febrero de 2014.
[2] http://www.ibol.org/phase1/cbol
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

Costa Rica provides detailed examples of measures facilitating and regulating access to genetic resources, their biochemical compounds and the indigenous knowledge associated with their use, for example the need for prior informed consent and equitable sharing of benefits. The indigenous communities of the country are engaged in a participatory process to determine how to implement prior informed consent based on similar agreed criteria throughout the country. The process is also addressing regulation of access to the intellectual property of indigenous communities. In terms of the sharing of benefits, the concept of benefit in the Costa Rica regulation can mean different things, ranging from monetary benefits such as royalties to free access to the technologies developed with the genetic resource or other non-monetary benefits of a cultural, social or environmental nature, including sharing of research results and strengthening local capacities, so long as agreement has been reached with the local communities.

According to the Costa Rica regulation on monetary benefits, a down payment of 10 percent of the research and/or bioprospection budget in a designated bank account owned by the community at the beginning of the project is mandatory. The utilization and/or exploitation of the genetic resource for commercial purposes implies payments to the community of up to 50 percent of the economic profit obtained. A limitation in this respect is that the provisions do not clearly differentiate between a biological resource (virtually any living organism) and a genetic resource (biological elements that have been scientifically proven to carry relevant genetic information for a given purpose). According to the country report, the Technical Office of the National Commission on Genetic and Biological Resources has, to date,[10] issued more than 450 access permits for basic research on and prospection for genetic resources, with applications having been submitted in

[10] The country report is dated December 2015.

the fields of biotechnology, human and animal health, taxonomy and evolution, conservation and ecology, agriculture and industrial applications.

2.3.1 Needs and priorities

Most country reports indicate needs and priorities with regard to the regulation of access and exchange, especially with regard to specific BFA-related needs (see Table 16 for a summary). Countries noted (i) the need to develop policies concerning access and exchange, with emphasis on the sharing of benefits and (ii) the need to train personnel and develop institutional capacities to implement such legal mechanisms. The need to bring current national regulations into line with the Nagoya Protocol and other standards was also singled out. Several reports note a legal gap in terms of access and benefit sharing regulations addressing associated biodiversity (as opposed to domesticated genetic resources and wild foods).

Table 16. Reported needs and priorities in terms of access to and exchange of biodiversity for food and agriculture in Latin America and the Caribbean

Country	Needs and priorities
Ecuador	- Establish a legal framework to regulate access to and sharing of genetic resources Align the current National Regulation on Access to Genetic Resources[1] with the provisions of the Nagoya Protocol, the International Treaty on Plant Genetic Resources for Food and Agriculture, the United Nations Convention on the Law of the Sea, the World Intellectual Property Organization and Decision 391 of the Andean Community (Establishing the Common Regime on Access to Genetic Resources)[2] Implement capacity development among ministries and evaluation entities on: • conceptualization and formulation of policies, laws, strategies and programmes; • implementation of policies, laws, strategies and programmes and decision-making; and • implementation, supervision and evaluation of formal requests to access genetic resources
El Salvador	- Ensure effective implementation of laws to protect associated biodiversity (currently a legal void)
Grenada	- Develop relevant policies and regulations regarding access to and fair and equitable sharing of benefits arising from the utilization of biodiversity for food and agriculture - Engage policy-makers and decision-makers to build their awareness of the need for such policies
Jamaica	- Provide fishers with security of land tenure for fishing beaches - Develop active fishing cooperatives and associations
Mexico	- Develop public policies on associated biodiversity - Establish long-term interinstitutional programmes that are not affected by changes of administration - Develop a national strategy for the conservation and use of associated biodiversity - Finish the ongoing elaboration of a law to regulate access to genetic resources and the sharing of benefits derived from the implementation of the Nagoya Protocol
Nicaragua	- Strengthen the capacity of national institutions to implement the Nagoya Protocol - Promote regional cooperation and exchange of experiences on the implementation of the Nagoya Protocol
Panama	- Improve coordination between government institutions for the creation of protected areas and coordination of access to biodiversity - Integrate the knowledge generated through research and development projects into norms and conservation programmes - Strengthen capacities to plan and prioritize conservation objectives - Involve different stakeholders in the formulation of conservation and access norms - Improve the supply of qualified personnel
Peru	- Enforce the application of the law recognizing rights and regulating the sharing of benefits - Obtain detailed and trustworthy information, inventories and evaluations of the current conservation status of associated biodiversity - Identify relevant conservation thresholds (e.g. for fish species) - Establish long-term planning and policies that implement national laws and strategies beyond government terms - Strengthen coordination and cooperation between institutions dealing with biodiversity for food and agriculture, especially associated biodiversity - Eliminate redundancy and opposition between the various laws that regulate biodiversity
Suriname	- Develop and enforce legislation on intellectual property rights - Develop a clear policy with regard to biodiversity

[1] Decreto Nº 905 – Reglamento nacional al Régimen común sobre acceso a los recursos genéticos. Registro Oficial Nº 553, 11 de octubre de 2011 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/c/LEX-FAOC139176/).
[2] Available at http://www.wipo.int/wipolex/en/details.jsp?id=9446
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

III. Policies, institutions and capacity

3.1 POLICIES, PROGRAMMES, INSTITUTIONS AND STAKEHOLDERS

This section describes relevant policies and programmes that countries in the region have adopted and are implementing to support the conservation and sustainable use of BFA, specifying where possible the extent to which they address associated biodiversity and wild foods. Relevant policies and programmes in this realm include those that address:

- the coordinated use and conservation of genetic resources;
- food security and nutrition;
- the sustainable use and conservation of associated biodiversity;
- the maintenance of ecosystem services;
- improving the resilience and sustainability of production systems; and
- the application of ecosystem/landscape/seascape approaches.

Relevant policies and programmes also include those that support farmers, livestock keepers, forest dwellers and fisher folk in the adoption and maintenance of practices that strengthen the conservation and use of BFA. Such policies and programmes include those that provide incentives or benefits such as payments, provision of inputs and subsidies. Among the policies and programmes concerned with food security and nutrition that countries reported, only those that make explicit reference to associated biodiversity and/or wild foods are considered here.

Some countries indicated that they currently have no policies in place that *explicitly* address the use and management of BFA and therefore did not respond to the respective questions in the country-reporting guidelines. The country reports do not mention policies or programmes that specifically target associated biodiversity and wild foods. Costa Rica, for instance, indicates that current efforts to preserve, for example, micro-organisms of importance for agriculture have been personal initiatives on the part of individuals and not coordinated policies. Nonetheless, many of the policy mechanisms described by countries, for example general regulations on biodiversity, cover components of BFA. Only a few of the reports analyse the strengths and weaknesses of current policies and programmes.

Examples of reported policies and programmes that address the dimensions outlined above are summarized in Table 17. In selecting the examples, the role of and/or the implications for BFA were examined and only the most relevant cases included. The intention was also to select examples from a range of reporting countries and to illustrate the diversity in the types of support mechanisms reported. Strictly speaking, some of the policies and programmes reported, including some of those presented in Table 16, are not policies but national laws that regulate, mandate and guide the development of relevant policies. In several cases, countries reported that such laws are being developed or have been approved but not yet promulgated or implemented.

Table 17. Examples of reported policies and programmes supporting the sustainable use and conservation of biodiversity for food and agriculture in Latin America and the Caribbean

Domain	Policy/programme	Description	Country
Resilience and sustainability of production systems	Law No. 9036 on the creation of a Rural Development Institute[1]	The Rural Development Institute[2] was created with the objective, *inter alia*, of promoting the development of organic agriculture and sustainable agro-industries through the use and management of biodiversity and natural resources for the provision of ecosystem services in productive landscapes, including labelling and quality certification mechanisms for value addition	Costa Rica

Table 17 *Cont'd*

Domain	Policy/programme	Description	Country
Application of an ecosystem/ landscape/seascape approach	National Programme for Ecosystem and Landscape Restoration[3]	Supports landscape restoration and prevents degradation through, for example, climate-smart and biodiversity-friendly agriculture, agroforestry and synergistic development of physical and ecological infrastructure, focusing on critical ecosystems	El Salvador
Conservation and sustainable use of biodiversity	National Biodiversity Strategy and Action Plan	Promotes actions and strategies to support agreements aligned with the CBD, including the incorporation of ecosystem services into national accounting systems	Grenada
Sustainable use and conservation of associated biodiversity	Creation of marine protected areas such as Shell Beach Code of Conduct for Captains	Provides a reservoir of species richness indigenous to Guyana Promotes efficient management of fishing operations by advocating the use of sustainable practices	Guyana
Sustainable management of aquaculture resources	The Fishing Bill to be taken to Parliament, and National Fisheries and Aquaculture Policy	Covers the management and regulation of aquaculture, which was previously not addressed, and also support for international management and conservation measures, including high-seas fisheries among other critical areas	Jamaica
Application of an ecosystem/ landscape/seascape approach	Conservation for Sustainable Development Programme, National Commission on Protected Areas[4]	Public policy supporting participatory planning, studies, capacity development and projects focused on natural protected areas, their influence zones and other priority regions for the conservation of ecosystems, including their social components and their economic and cultural dimensions	Mexico
Coordinated use and conservation of genetic resources	National Programme on Innovation, Research, Technology Development and Education: Aquatic Genetic Resources	Promotes and supports the conservation, characterization, evaluation, management, breeding, reproduction and sustainable use of aquatic genetic resources	Mexico
Sustainable use, access and benefit sharing	National Law Ratifying the CBD (1995)[5]	Regulates the sustainable use and conservation of biodiversity, along with access and the fair sharing of benefits	Panama
Sustainable use and conservation of associated biodiversity	Regulation on Responsible Fishing in the Amazon river[6]	Establishes norms and guidelines for the rational and sustainable use of native aquatic resources through a code of conduct	Peru

[1] Ley 9036 – La Asamblea Legislativa de la República de Costa Rica decreta: transformación del Instituto de Desarrollo Agrario (IIDA) en el Instituto de Desarrollo Rural (INDER). La Gaceta Nº 103 — Martes 29 de mayo del 2012 (available, in Spanish, at http://www.fao.org/faolex/results/details/en/c/LEX-FAOC113249).
[2] https://www.inder.go.cr/
[3] http://www.marn.gob.sv/descargas/plan-de-accion-de-restauracion-de-ecosistemas-y-paisajes-de-el-salvador-con-enfoque-de-mitigacion-basada-en-adaptacion-proyecto-2018-2022
[4] http://www.gob.mx/conanp
[5] Ley n 2 de 12 de enero de 1995 por la cual se aprueba el Convenio sobre la Diversidad Biologica, hecho en Rio de Janeiro el 5 de junio de 1992.
[6] Decreto Supremo Nº 015/09/PRODUCE – Reglamento de ordenamiento pesquero de la Amazonía peruana (available, in Spanish, at http://www.fao.org/faolex/results/details/en/c/LEX-FAOC090489).
Source: Country reports prepared for *The State of the World's Biodiversity for Food and Agriculture* (FAO, 2019).

Several country reports indicate international conventions and agreements as mechanisms of support for the sustainable use of BFA, including the Nagoya Protocol, the International Treaty on Plant Genetic Resources for Food and Agriculture, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Ramsar Convention on Wetlands of International Importance, the International Agreement on Tropical Timbers, the United Nations Convention to Combat Desertification and Droughts and the United Nations Convention on the Law of the Sea.

Some countries reported that they did not have specific programmes for genetic resources or BFA, but had programmes and laws that indirectly protect biodiversity. For example, El Salvador has no national programme or law on BFA, but the Ministry of Agriculture and Livestock has delegated the conservation, sustainable use and the fair and equitable sharing of plant genetic resources to the National Centre for Agriculture and Forestry Technology "Enrique Alvarez Córdova" (CENTA),[11] which has formed a national commission involving public and private institutions, universities and non-governmental organizations to address the management and conservation of genetic resources. CENTA is one of the founding institutions of the Mesoamerican Plant Genetic Resources Network. Suriname reported on the recent creation of its National Coordinating Commission on Plant Genetic Resources[12] and referred to mechanisms such as its National Biodiversity Action Plan, Fourth National Biodiversity Report, National Biodiversity Strategy Plan 2006–2020 and National Bio-Inventory, as well as to the establishment of Mangrove Forum Suriname in 2014 and awareness campaigns for farmers regarding Criollo cattle and the Oso-fowru's chicken breed, which face the risk of extinction.[13]

Most countries reported food security policies and programmes, but their links to BFA were not made explicit. There may even be conflicting objectives in different strategies or programmes. Mexico's Strategic Project for Food Security, led by the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), with technical support from FAO, aims to achieve food security among the population in marginal rural environments, with BFA playing a central role (cf. PESA Mexico, 2014). At the same time, SAGARPA's the Integral Programme for Rural Development: Sustainable Modernization of Traditional Agriculture, led by the International Maize and Wheat Improvement Center, aims to "modernize" traditional agriculture in Mexico through, *inter alia*, the replacement of local and traditional maize biodiversity with high-yielding hybrids and the use of external inputs of energy, nutrients and toxic agrochemicals that have adverse impacts on biodiversity.

Ecuador's National Assembly is preparing an environmental code (Codigo Orgánico Ambiental) on biodiversity and genetic resources as a major step towards the development of strategies to guide conservation and to control and promote biodiversity including BFA. Highlights from the draft law include:

- Article 2, "… and help promote conservation, sustainable management and restoration of ecosystems, biodiversity and its components, national forest patrimony, management of environmental services, coastal marine zones and other natural resources."
- Article 19, "Regulating and controlling access, conservation, management, sustainable use of biological resources, genetic resources, their derivatives and synthetics, and the fair and equitable sharing of the benefits associated with biodiversity in coordination with the Science Technology Innovation and Ancestral Knowledge Authority."
- Article 20, "... regulates the conservation of biodiversity, sustainable use of its components and the fair and equitable sharing of benefits arising from them."
- Article 21 refers to the objective "... to conserve, manage and sustainably use biodiversity, ecosystems, species and genetic resources maintaining ecological functions and dynamics to ensure its resilience, both for intrinsic reasons and for human welfare."

In terms of programmes that provide support to rural and coastal people for the sustainable use and conservation of biodiversity, the report from Mexico mentions the Programme of Subsidies to Civil Society Organizations, which promotes processes that relate to sustainable development, self-employment, natural-resource conservation and food self-sufficiency among groups of men and women belonging to rural communities. Subsidies are provided to civil society organizations to finance gender-sensitive sustainable development initiatives with emphasis in indigenous peoples. The description of the initiative does not provide explicit information on links to BFA. However, several indirect but positive effects may be expected, as knowledge about the conservation

[11] http://www.centa.gob.sv/2015/

[12] http://www.fao.org/pgrfa-gpa-archive/sur/comiteil.html

[13] The country report cites the country's *MDG Progress Report 2014* (Government of Suriname, 2014) with regard to these awareness-campaigns.

and management of BFA is largely embedded within rural and indigenous communities, and particularly among women.

3.1.1 Strengths and weaknesses

As noted above, most countries did not report on strengths and weaknesses related to policies, programmes, institutions and stakeholders and those that did (with one exception) reported exclusively on weaknesses. The report of Grenada identifies the following strengths: that policies and programmes are very comprehensive and have been developed through public consultations; that action plans are implementable; that instruments have been endorsed by the political directorate; and that they were developed with inputs from technical experts. As weaknesses, it notes that some of the programmes have not been supported with the necessary levels of financing and that programmes have not been widely adopted. Weaknesses indicated in other country reports include:

- lack of clear delimitation of mandates and responsibilities regarding the conservation and sustainable use of biodiversity across governmental ministries (Costa Rica);
- lack of political will and economic resources for the implementation of a true national plan for both genetic resources for food and agriculture and associated biodiversity (Costa Rica);
- protracted delays in enacting new laws and public consultations, which require designation of a green paper by the Cabinet (Jamaica);
- poor enforcement of laws and regulations and insufficient monitoring, with responsible agencies inadequately staffed (Jamaica);
- insufficient financial resources and a general lack of understanding of the consequences of biodiversity loss for the island (Jamaica);
- need for a more coherent framework that will integrate all the existing policies and provide a mechanism for creating the necessary synergies between policies (Saint Lucia);
- need to strengthen programmes that coordinate activities in the country, including all institutions; need for closer integration with the environmental sector and NGOs and harmonization with the CBD (El Salvador);
- need to review legal frameworks, particularly in the realm of protected areas, to eliminate jurisdictional conflicts and optimize resource allocation (Grenada);
- lack of resource-management plans and baselines, especially in the marine environment and continental fisheries, but also in the use of wild palm trees such as *aguaje* and *chonta* (Peru); and
- dismantling of the state and partially incomplete decentralization in all sectors; for example, in the fisheries sector, there is an overlap of functions and mandates between marine and land authorities; they interfere with each other with respect to the definition of priorities, provision of use rights, monitoring and enforcement – and this prevents the implementation of ecosystems approaches (Peru).

3.1.2 Interministerial cooperation

As noted at various points above, a number of countries mentioned a lack of connectedness and collaboration between ministries or a lack of clarity regarding responsibilities and mandates. This subsection presents some examples, taken from the country reports, of interministerial cooperation in the field of conservation and sustainable use of BFA, including, where available, information on the collaboration mechanisms involved. What is not always clear from the reports is how successful the cooperation has been so far.

The Government of Jamaica Adaptation Fund Program started in 2012 and is being implemented by the Planning Institute of Jamaica in partnership with the National Environmental and Planning Agency, the National Works Agency, the Ministry of Agriculture and Fisheries, the Rural Agricultural Development Authority, the National Irrigation Commission, the Ministry of Tourism and Entertainment and the Office of Disaster Preparedness and Emergency Management.

The first component of this project was developed in response to the problem of coastal erosion and involved installing breakwater structures along the Negril coastline to reduce the exposure of coastal and environmental assets to storms and storm surges, restore and improve the functions and services of coastal ecosystems (seagrass beds and coral reefs) and protect fishing livelihoods.

Saint Lucia's Ministries of Agriculture, Health and Education have increased their collaborative efforts in the last three years to highlight the nexus between agriculture, nutrition and health and to promote the use of safe locally produced foods in the fight against non-communicable diseases. This collaboration is ongoing and is expected to increase awareness of the role of agricultural biodiversity in healthy lifestyles and to promote the sustainable use of agricultural biological resources. Diversifying local agriculture and promoting local production of healthy foods is expected to improve food availability and help ensure food and nutritional security. In Panama, the Ministry of Environment is promoting cooperation and coordination between different institutions within the country to meet the Aichi Targets. The Interinstitutional Environmental System was created in 2006 to coordinate efforts on environmental issues, including biodiversity conservation. Ecuador reports on the Food and Nutrition Integral Programme,[14] within the framework of the "Nutrition Action" National Strategy,[15] which involves the Ministry for the Coordination of Social Development, Ministry of Public Health, Ministry of Housing, Ministry of Agriculture, Livestock, Food and Fisheries and the Ministry of Economic and Social Inclusion.

Climate change is another issue that brings together ministries and other governmental bodies. Costa Rica, for example, has created a Technical Interinstitutional Commission for Climate Change. This body currently involves the Ministry of Environment and Energy and the Ministry of Agriculture and Livestock and there are plans to involve other ministries in the future. Its task is to prioritize agendas and implement the National Strategy on Climate Change. Similar approaches have been followed by Panama, Peru and Mexico.

3.1.3 Needs and priorities

The needs and priorities reported by countries with regard to policies, programmes and institutions addressing BFA were not necessarily specific to these areas of activity. For example, needs for research funding, qualified personnel, baseline studies and databases are not specific to policy development. Likewise, as described above, reported needs and priorities related to sustainable use and conservation and to access and benefit sharing often included the need to establish policies and programmes. As a general pattern, countries that do not have policies and regulations targeting BFA in place regard the development and implementation of instruments of this kind as a priority. Countries that have instruments in place indicate that greater interinstitutional (interministerial) coordination is the main priority. Reported needs and priorities in this field are listed in Table 18.

Table 18. Reported needs and priorities for the assessment and monitoring of biodiversity for food and agriculture in Latin America and the Caribbean

Country	Needs and priorities
Bahamas	- Increase the participation of small states in the protection and preservation of genetic diversity at the global level - Increase the availability of trained personnel and financial resources to implement thorough inventory and conservation activities - Inventory genetic resources, enact necessary legislation and promote greater public awareness of, and wider public participation in, conservation efforts - Expand the training of personnel involved in conservation activities - Further develop and maintain permanent conservation sites - Foster greater conservation consciousness among the population
Costa Rica	- Integrate the disciplines and activities of ministries, universities and other institutions - Improve knowledge of the relationships, behaviour, status and effects of associated biodiversity

[14] http://plataformacelac.org/programa/39
[15] https://educacion.gob.ec/estrategia-accion-nutricion

Table 18 *Cont'd*

Country	Needs and priorities
Ecuador	- Expand knowledge and information on genetic resources - Develop multidisciplinary long-term research programmes with adequate funding, in order to be able to inform policies and decision-making - Reduce instability in terms of personnel in public bodies and take steps to prevent loss of information when employees leave - Keep websites and other such depositories of information up to date - Make information publicly available and transparent, especially information from private parties - Promote the scientific publication of existing information
El Salvador	- Implement awareness-raising programmes to sensitize youth in schools and private firms in coordination with international organizations - Establish a national programme on genetic resources
Grenada	- Provide tools, equipment and training in capacity-building to all stakeholders who interface with biodiversity - Enforce regulations governing the management of biodiversity - Build awareness among the entire population on the role and importance of the conservation of biodiversity for food and agriculture
Guyana	- Implement and support existing international mechanisms/instruments that promote the increased use of biodiversity in agriculture - Develop, implement, monitor and evaluate national policies/strategies to assist in the management and protection of biodiversity in agricultural ecosystems - Develop monitoring systems for implemented programmes, action plans, strategies and policies - Promote awareness of the importance of ecosystem services and the conservation and sustainable use of biodiversity for food and agriculture among policy-makers and institutional leaders, so that focus can be placed on these areas in the future
Jamaica	Strengthen the legislative framework so as to address plant protection, access to genetic resources, benefit sharing, alien species and Ramsar sites - Allocate responsibility for implementation of the National Biodiversity Strategy Action Plan - Finalize and implement the Protected Areas (System) Master Plan, including closing representational gaps
Mexico	- Establish long-term intersectoral programmes that have adequate funding - Establish long-term interinstitutional programmes that are not affected by changing administrations - Create an intersectoral commission to promote the elaboration of public policies on the conservation and use of biodiversity for food and agriculture and to monitor them
Nicaragua	Develop infrastructure, technology and qualified human resources for the conservation and diversification of marine and terrestrial production systems
Panama	- Promote a cooperation agreement between Panama and countries whose territories are crossed by the migratory routes of coastal land and marine species such as jaguars, birds, sea turtles, sharks and cetaceans, to protect these species, based on the Convention on the Conservation of Migratory Species of Wild Animals (CMS), Convention on Biological Diversity and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
Peru	- Give priority to the provision of political and financial support for research on biodiversity for food and agriculture - Develop databases and digitalize maps - Disseminate information on the implementation of restoration programmes through the social media
Saint Lucia	- Urgently develop a proper management system for biodiversity for food and agriculture - Develop a clear policy on biodiversity
Suriname	- Address gaps in knowledge and shortages of specialists and financial resources in fields related to biodiversity for food and agriculture - Develop plans and establish institutions to implement policies for biodiversity for food and agriculture - Provide the technical and financial assistance needed to write plans and develop human capital

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

3.2 CAPACITY

3.2.1 Training and education needs

Most reporting countries identified training and education needs related to BFA management. Particular emphasis was placed on the management of associated biodiversity for the delivery of ecosystem services of importance to agricultural production. The main reported priorities can be summarized as follows:

- higher education programmes on, or that include, BFA and its management;
- capacity development and training of professionals and field technicians on biodiversity management and conservation (covering technical and legal matters);
- training of farmers on aspects of sustainable use and management, particularly of associated biodiversity; and
- training of communicators in the sensitization of the public opinion.

The report from Mexico suggests the creation of an institute or national centre for research and university-level education in the field of BFA. The report links the lack of interest in genetic resources in legislative agendas partly to the lack of trained professionals in the policy-making arena. The creation of a national centre of this kind would contribute to the development of well-informed policies, a national information system, university curricula on BFA and a national strategy for the use and conservation of associated biodiversity. Constraints to achieving this objective are mostly financial and material, according to the report, but there are also constraints in terms of human capacities. In terms of existing capacity, the report mentions the Institute of Genetic Resources and Productivity with its Postgraduate Programme on Genetic Resources for Food, and the National Centre for Training on Fisheries and Aquaculture, which identifies capacity gaps and develops ad hoc programmes for training and capacity development.

Grenada's report, at the other end of the spectrum, points to "a dire need for professional capacity building and training" in basic areas such as ecology, land-use management, fisheries management, forestry management, watershed management, entomology, plant pathology, water-resources management, biosafety, veterinary medicine, zoology, botany, general biology, invasive species, nematology, bacteriology, environmental sciences, marine biology and plant breeding. The report from Jamaica indicates that training is needed in responsible fishing practices, promotion of fishers' associations, data collection and compliance with licenses for fishers and vessels. Guyana's report notes that training can improve awareness, and suggests incorporating training on biodiversity into agricultural undergraduate and postgraduate programmes at the University of Guyana.

The report from Panama notes the need for postgraduate study programmes on genetic resources and biodiversity, but also emphasises the need for training and capacity development among farmers and field professionals on the sustainable management of BFA. It identifies the need to train experts on practical legal aspects of genetic resources management such as patents, rights, benefits, regulations, negotiations and international conventions. It also identifies capacity gaps in the fields of collection and conservation (*in situ* and *ex situ*), inventory and evaluation of associated biodiversity and underutilized food species, domestication of wild species, ethnobotany, prebreeding, management of the natural resource base, and commercialization of underutilized species. Ecuador's report highlights the recent creation by the government of a centre for academic excellence in Amazonia, the Ikiam, which constitutes an opportunity for the development of a curriculum on the sustainable use and conservation of BFA.

3.2.2 Research needs

Research needs on associated biodiversity, wild foods and ecosystem services are generally not singled out or prioritized, as such, in the country reports, which makes it difficult to tabulate them in this synthesis report. Nonetheless, research needs in these areas are noted throughout the country reports in the various "needs and priorities" subsections, where they often appear as knowledge, information and data needs (see Tables 8, 14, 16 and 18). Table 19 provides a summary. Further research needs, as identified by regional experts during the informal regional consultation in Panama City, in March 2016, are listed in the report of that meeting (FAO, 2016). Soil micro-organisms, their conservation and their management in agricultural (crop and livestock) and forest production stand out as frequently reported research priorities. Several countries noted the need for baseline inventories and national-level diagnosis of genetic resources and associated biodiversity. The need for research on wild pollination and on indigenous management of biodiversity was also repeatedly noted.

Table 19. Reported research needs related to the conservation and sustainable use of associated biodiversity, wild foods and ecosystem services in Latin America and the Caribbean

Country	Research areas	Capacity-building, policies and institutional development
Costa Rica	- Roles of biodiversity in agricultural systems (national-level diagnosis required) - Pollinators, especially insects - Climate change impacts on flora and fauna - Soil micro-organisms and forest growth - Country inventories of associated biodiversity, especially pollinators - Design of biodiversity-rich farming systems - Associated biodiversity and wild food species and their relation to climate change, ecosystem services, natural disasters and invasive species - Systems that treat biodiversity as an "input" to agricultural production, water conservation, forest management and rural poverty reduction - Indigenous management of biodiversity - Status and trends of wild pollinators - Relationships, behaviour, status and effects of associated biodiversity	
Ecuador	- The state of biodiversity at country level - Climate change impacts on biodiversity (baseline studies and indicator-based assessments) - Genetic resources pertaining to beneficial soil organisms and their use - Soil micro-organism biodiversity and soil genetic resources (collection and inventory) and means of promoting their possible sustainable use in agriculture - Loss and genetic erosion of traditional species and wild foods - Sustainable use of associated biodiversity (long-term research programmes needed) - Forest genetic resources, particularly those used as food and for other purposes - Genetic resources in general (through multidisciplinary research programmes with enough funding and duration to support decision-making) - Aquaculture genetic resources (addressing the fragmented and dispersed nature of current information) - The country's ecosystems and the dynamics of drivers affecting them (detailed characterization) - Knowledge that supports agroecology and facilitates the sustainable use and conservation of biodiversity	- Incentivize and facilitate the training of scientists and strengthen the research output of current organizations with existing resources and facilities - Integrate information that is currently fragmented, incomplete and/or dispersed - Promote a strong culture of scientific publishing
El Salvador	- Inventory of biodiversity and genetic resources for food and agriculture - Compilation of traditional knowledge on the sustainable use of biodiversity - Development of less expensive conservation technologies	
Grenada	- Drivers affecting biodiversity - Sustainable use of associated biodiversity	
Guyana	- National level diagnosis - Genetic characteristics and overall status of Guyana's animal, aquatic, plant and forest genetic resources - Management and sustainable use of biodiversity for food and agriculture	- Develop policies that guide agricultural research institutions towards ecological studies and studies relating to effective management and sustainable use of biodiversity for food and agriculture
Jamaica	Sustainable use of wild food species	
Mexico	- Status and trends of biodiversity for food and agriculture - Characterization and evaluation of native species (field research) - More robust environmental indicators	- Coordinate research efforts across institutions and better integrate existing isolated knowledge on biodiversity for food and agriculture

Table 19 *Cont'd*

Country	Research areas	Capacity-building, policies and institutional development
Panama	- Genetic resources, biodiversity, ecosystems and the environment (baseline research) - Activities that support sustainable use, conservation and access and benefit sharing, with specific emphasis on biodiversity for food and agriculture - Carrying capacity of protected areas with high biological diversity - Potential impacts of climate change on family agriculture and its biodiversity - Value of ecosystem services associated with biodiversity - Use and conservation of wild foods and wild relatives of food-crop and livestock species - Role of women in the conservation of biodiversity for food and agriculture - Implementation of agroecological approaches to food production - Associated biodiversity (redesign and update research programmes)	- Establish a database on genetic resources, biodiversity, ecosystems and environment - Adopt ecosystems approaches in research
Peru	- Inventory of biodiversity in production systems - Distribution and dynamics of biodiversity at national level - Invasive and exotic forest species - Sustainable use of biodiversity for food and agriculture and associated biodiversity - Basic biodiversity research (more investment required) - Functioning of marine ecosystems, particularly with regard to invasive algae species - Effects of climate change on biodiversity dynamics and distribution - Effects of climate change on shifting forest biodiversity patterns - Conservation methods for biodiversity for food and agriculture - Current status of biodiversity for food and agriculture	
Saint Lucia	- Status of biodiversity for food and agriculture and associated ecosystem services - Variability in wild food species and characteristics of associated biodiversity	
Suriname	- Sustainable use of biodiversity for food and agriculture - Management of genetic resources, associated biodiversity and ecosystem services	

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

Constraints to addressing the research areas listed in Table 19 were chiefly reported to be a lack of funding and human resources, and secondarily a lack of qualified personnel and infrastructure. Absence of political interest and will and insufficient institutional support were also reported to be constraints. Several countries indicated that conducting one-off baseline research is not enough: it was noted that funding needs to be secured by law in order to allow databases to be updated regularly and trends to be monitored. Another point raised was that changes of government and administrations in the region often lead to changes in research funding and that this affects the long-term continuity of research programmes. The report of Peru compiles a number of testimonies from national stakeholders from the research sector and academia, whose statements indicate a worrying absence of material support both for the basic research needed to support decision-making and for more-applied research related to the development of technologies. The reports from Costa Rica and Mexico note that the compartmentalization of research in the hands of different public organizations and companies that respond to particular interests means that information is fragmented and very often difficult to access. Actors, capacities and fields of interest in research on biodiversity urgently need to be mapped. Another major challenge identified in the field of research was the need to establish links between biodiversity inventories and ecosystem functions, particularly those relevant to the supply of ecosystem services to agriculture.

IV. Regional and international cooperation

4.1 MAJOR REGIONAL INITIATIVES ADDRESSING THE CONSERVATION AND USE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

In their reporting on regional policies and programmes, most countries focused on regions within their respective territories rather than on regions in the sense of groups of neighbouring countries. Most of the regional policies and programmes reported were thus subnational or national initiatives. Examples include Mexico's REDD+ National Strategy, El Salvador's Agroforestry Network, Costa Rica's National Biodiversity Plan and Peru's National Strategy for Climate Change Adaptation. These programmes, although relevant to BFA, are not multicountry initiatives. Table 20 lists the initiatives mentioned in the country reports that involve more than one country. The truly regional initiatives[16] reported involved the following collaborative elements and objectives:

- technology transfer;
- increasing stakeholder participation;
- increasing access to financial resources through participation;
- improving research facilities;
- exchange of expertise;
- training of scientists from national programmes;
- exchange of information;
- providing access to advanced research results;
- characterization and evaluation of germplasm;
- raising public awareness of plant genetic resources for food and agriculture; and
- avoiding duplication.

Some of the (transnational) regional initiatives reported were not explicitly concerned with BFA. Conversely, some relevant regional programmes in Latin America and the Caribbean that were not mentioned in the country reports. Examples include the Latin American Forest Genetic Resources Network,[17] the Andean and Amazonian Plant Genetic Resources Network and the Regional Global Environment Facility Project Strengthening the Implementation of Regimes of Access to Genetic Resources and Benefit Sharing in Latin America and the Caribbean, executed by the Regional Office for South America of the International Union for Conservation of Nature and implemented by the Regional Office for Latin America and the Caribbean of the United Nations Environment Programme. The reports of Peru and Ecuador call for stronger common action to conserve Andean crops and the knowledge associated with them, and note the need to foster technology transfer among countries.

Table 20. Regional policies and programmes embedding the conservation and/or use of biodiversity for food and agriculture in Latin America and the Caribbean

Regional policy or programme	Description	Countries involved
Mesoamerica Network on Genetic Resources	Supports conservation and sustainable use of genetic resources	Several countries of Mesoamerica (reported by El Salvador)
Regional Cooperation in Coffee Technology Development in Central America (PROMECAFE)	Provides support and exchange in the area of coffee cultivation (no explicit mentioning of biodiversity)	Dominican Republic, El Salvador, Panama and Jamaica (reported by El Salvador)
Caribbean Aqua Terrestrial Solutions Programme[1]	Provides support for the prudent management and conservation of terrestrial and marine biodiversity and ecosystem services	Caribbean region (reported by Grenada)

[16] International instruments such as the International Treaty on Plant Genetic Resources for Food and Agriculture, the CBD and the Nagoya Protocol were reported as examples of regional cooperation by some countries.

[17] http://www.bioversityinternational.org/research-portfolio/forests/laforgen/

Regional policy or programme	Description	Countries involved
Regional Fisheries Policy	Aims to ensure the sustainable management of fisheries resources within the Caribbean region, protecting marine biodiversity, habitats and ecosystem services	Caribbean region (reported by Grenada)
Caribbean Fish Sanctuary Partnership (C-Fish)[2]	Strengthens community-based fish sanctuaries and marine protected areas in five countries across the Caribbean to enhance the resilience and productivity of coastal ecosystems	Dominica, Grenada, Jamaica, Saint Lucia, Saint Vincent and the Grenadines (reported by Grenada and Jamaica)
Caribbean Regional Fisheries Mechanism (CRFM)/Caribbean Large Marine Ecosystems Project (CLME+)/Organization of the Central American Fisheries and Aquaculture Sector (OSPESCA)	CRFM, OSPESCA and the FAO Western Central Atlantic Fisheries Commission signed a memorandum of understanding to facilitate, support and strengthen the coordination of actions to increase the sustainability of fisheries	Caribbean region (reported by Jamaica)
Caribbean Sea Ecosystem Assessment	A project under the Millennium Ecosystem Assessment on the condition and trends of Caribbean ecosystems (USAID, 2008)	Caribbean region (reported by Jamaica)
Integrating Watershed and Coastal Area Management in the Small Island Developing States Project	Global Environment Facility project implemented by the United Nations Environment Programme and the United Nations Development Programme to strengthen the commitment and capacity of the participating countries to implement an integrated approach to the management of watersheds and coastal areas	Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Trinidad and Tobago (reported by Jamaica)
Eco-regional evaluation of the Great Chaco Forest	Transnational programme for zoning of conservation priority areas in the Great Chaco	Bolivia (Plurinational State of), Brazil, Paraguay

[1] http://caribbeancats.org/

[2] http://www.caribbeanclimate.bz/our-work/c-fish-project-eco-system-based-adaptation

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

4.2 NEEDS AND PRIORITIES

Although international coordination is essential, as demonstrated by existing – though not reported – regional initiatives, the countries reports do not explicitly indicate needs and priorities in terms of integrating BFA, and in particular associated biodiversity, wild foods and ecosystem services, into regional and international initiatives. This issue was, however, highlighted by the national focal points that participated in the regional consultation meeting. Moreover, as described in the respective sections above, countries indicated that regional/international cooperation and integration are priorities in the fields of monitoring, sustainable use, conservation and capacity development.

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The Latin America and the Caribbean 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 13 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 Latin America and the Caribbean's biodiversity for food and agriculture, held in Panama City, Panama, in March 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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