

have looked into the potential of sustainable intensification as a means of avoiding agricultural expansion into vulnerable areas. It notes that intensified crop rotations were found to allow improvements in grain yields and in the contribution of crop residues to soil carbon balance. Ethiopia mentions a project in the southwestern part of the country that introduced the use of improved fruit and vegetable varieties, along with practices such as the use of organic manure and integrated pest management, and resulted in a 60 percent increase in crop yields and a 70 percent improvement in nutrition in the areas targeted. It notes that similar activities have been implemented in other parts of the country and that most of the crop varieties involved were developed from landraces at the country's agricultural research centres. Several countries note the significance of breeding programmes that create high-performance varieties, breeds and strains that are resistant to stresses they are likely to encounter or note the importance of existing locally adapted crops or livestock that can function in low external input production systems.

#### 2.4.2 Needs and priorities

The country reports emphasize the need to increase research into the potential roles of BFA in sustainable intensification across a range of production systems and to generate, adapt or develop sustainable technologies – including approaches to land management – that meet the needs of producers and their communities. Reported priorities include improving knowledge of how existing practices and new technologies can best be combined to promote sustainable intensification. Several countries note the importance of strengthening genetic-improvement programmes for local breeds and varieties of livestock and crops.

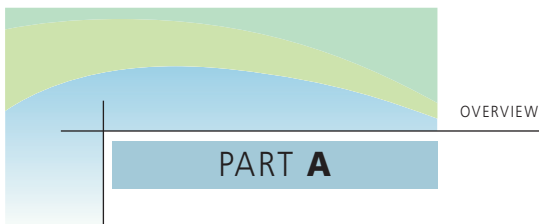
Countries highlight the importance of increasing the availability of financial resources for research on sustainable intensification and for the implementation of sustainable-intensification practices and note the need to promote the involvement of both the public and the private sectors. Several mention the need to develop incentive measures to encourage the adoption of sustainable practices

by producers. Raising awareness among policy-makers and local communities of the potential significance of sustainable intensification to food security and nutrition – and of the significance of BFA in this regard – is noted as another priority. Some countries also mention the need to monitor and establish indicators for the implementation of sustainable intensification in agriculture.

The thematic study prepared by Dawson *et al.* (2018a) draws attention to a number of challenges involved in the design and implementation of sustainable intensification strategies and interventions. In addition to the need for greater understanding of the various components of BFA and their interactions, it notes the need to investigate factors influencing levels of adoption, such as the amount of labour, knowledge and time required relative to other practices, as well as potential constraints associated with institutional and governance systems. It further notes the need to determine how to tailor sustainable intensification strategies and interventions to local agroecological conditions and to socio-economic factors such as dietary preferences. The need for interdisciplinary research approaches to all these questions is emphasized. At a more technical level, priority actions identified (largely focused on the crop sector) include the following: greater focus on adaptive-trait breeding for staple crops based on landrace and wild gene pools; support for the diversification of farming systems by focusing on strengthening positive interactions between biological components and promoting greater investment in more nutrient-rich orphan and new crops; and greater attention to spatial planning to maximize positive interactions between components of BFA.

### 2.5 Livelihoods

- Biodiversity for food and agriculture (BFA) is indispensable to livelihoods in countries at all levels of development, providing a wide variety of goods and employment opportunities, contributing to local culture, strengthening food and nutrition security – particularly among marginalized groups and in



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resource-poor areas – and increasing the resilience of production systems to adverse events.

- Actions that need to be taken to support the livelihood-enhancing roles of BFA include:
  - better documenting its multiple contributions, including documenting indigenous knowledge related to its use;
  - raising awareness of the significance of its livelihood roles; and
  - creating appropriate policies in fields such as marketing of sustainably supplied products (e.g. certification schemes) and agro-ecotourism.

According to one widely cited definition, a livelihood “comprises the capabilities, assets (stores, resources, claims and access) and activities required for a means of living; a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global levels and in the short and long-term” (Chambers and Conway, 1991). In this sense, the livelihoods of the world’s farmers, livestock keepers, forest-dwellers, fishers and aquaculturists involve drawing on (*inter alia*) the assets represented by components of BFA and using and combining them in various ways to meet their needs.

**2.5.1 Overview of the contributions of biodiversity for food and agriculture**

According to the so-called sustainable livelihoods approach – a framework developed during the 1990s to analyse livelihoods (particularly the livelihoods of the rural poor) and potential development strategies or interventions (Carney, 1998; Scoones, 1998) – livelihood assets can be grouped into various categories of “capital”, typically financial, physical, natural, social and human capitals. Although these categories are not necessarily completely distinct from each other and can be interpreted in various different ways, the framework serves to illustrate the diverse range of assets and activities that make up many livelihoods, and provides a structure within which the livelihood significance of BFA can be

discussed. The framework is illustrated in Figure 2.2: a household combines its various categories of assets into a strategy aimed at coping with the various challenges it faces (“the vulnerability context”) and achieving desirable “livelihood outcomes”.

**Financial capital**

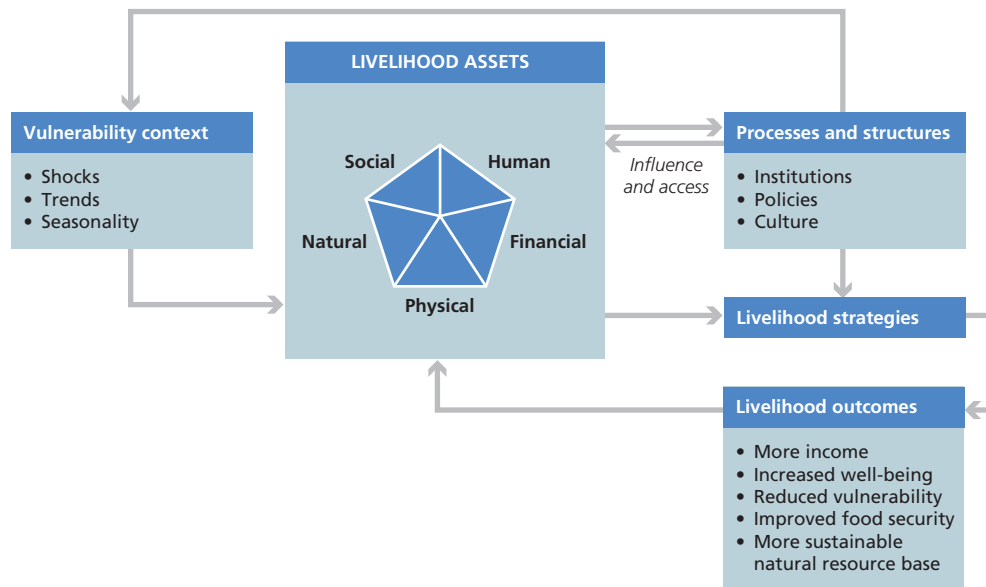
“Financial capital” in the livelihoods context refers to the cash assets to which an individual or a household has access. These assets can be used to purchase items that either directly contribute to well-being (e.g. food, medicines and various consumer goods and services) or can be invested in making improvements to the productivity or resilience of livelihood activities (tools, land, seeds, animals, fertilizers, feeds, veterinary medicines, etc.).

Clearly, many products and services derived from biological resources can be sold to obtain cash income. The significance of diversity in this context lies, in part, in the fact that access to a range of different components of BFA (e.g. a range of species, breeds or varieties) can help allow a household to maintain a supply of saleable products in diverse and fluctuating environments and in response to changes in market demand. However, the financial role of BFA is not necessarily restricted to the supply of a steady stream of products that can immediately be converted into cash. Where conventional financial services are unavailable, biological assets can also serve as alternative forms of savings or insurance. This is a well-documented function of livestock, for example (e.g. Ayalew *et al.*, 2003; Ejlertsen, Poole and Marshall, 2012; Moll, 2005). Cash can be “banked” in a herd or flock of animals that can then be sold when need arises. Other resources that may otherwise be of little value such as food waste, crop residues or vegetation from uncultivated rangelands, wastelands, roadsides, etc. can also be converted into savings by feeding them to the animals. If things go well, the flocks and herds will also yield “interest” in the form of offspring, milk, eggs, etc.

**Physical capital**

A household’s assets will include items that have not yet been, or will never be, converted into cash.

FIGURE 2.2  
The sustainable livelihoods analytical framework



Source: Adapted from FAO (2012a) based on Randolph *et al.* (2007) and Carney *et al.* (1999).

As in the case of financial capital, this so-called “physical capital” can serve directly to meet human needs (e.g. crop plants, livestock, forest trees or aquatic species can provide food, transport, shelter, clothing, etc.) and serve as inputs to further livelihood activities (e.g. crops and trees can provide feed for use in animal production, animals can provide draught power for use in crop production, trees can provide timber for use in making tools for various livelihood activities). Again, as in the case of marketed products and services, fulfilling these diverse roles across a range of different production environments requires a range of different species, varieties and breeds.

#### Natural capital

“Natural capital” refers to the natural resources and processes that a household (or individual or group) can draw upon. Where BFA is concerned, the boundaries of this category are rather blurry.

In a sense, all the functions of all components of BFA could be included. However, some components of BFA are more “natural” than others in that they have not been domesticated and/or are not actively managed by humans. Moreover, as described above, many types of BFA (crops, livestock, species used in aquaculture, and major harvested tree and aquatic species) are key contributors to the financial and physical assets of large numbers of households. The main focus under this subheading is on BFA falling outside these “sectoral” categories.

As described throughout this chapter and throughout the report, associated biodiversity contributes in many ways to the supply of supporting and regulating ecosystem services that are drawn upon at household level, whether passively or through active use (see in particular Sections 2.2 and 2.4, and Chapter 5). Likewise, wild biodiversity is widely used as source of food and other

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products (see in particular Section 2.6). However, while everyone's livelihoods and well-being depend ultimately on ecosystem services and functions, some households are more dependent than others on the services directly provided by their local ecosystems. These may often be households that are not well endowed with other assets. For example, if food is in short supply (e.g. because of a poor harvest), households that have plenty of "financial capital" may be able to buy the food they need despite higher prices, while those that are poorer may have to fall back on harvesting wild foods. Similarly, regulating and supporting services provided by wild biodiversity may be particularly important to poorer households as they often come at little or no direct cost to the beneficiary. For example, wild biological control agents may be particularly important for farmers that are unable to afford purchased pesticides.

However, while some studies have, indeed, indicated that poorer sections of the community tend to be particularly dependent on products obtained from the wild (e.g. Béné *et al.*, 2009; Cavendish, 2000; Jodha, 1992; Shackleton and Shackleton, 2006), it may not be correct to assume that this is a general rule (Vira and Kontoleon, 2012). In some cases, the relationship between the use of particular wild resources and wealth is positive (i.e. wealthier households use more than poorer ones) or U-shaped (i.e. the poorest and the richest use more and those with intermediate levels of wealth use less) (*ibid.*).

Various factors can influence access to wild resources and capacity to use them. For example, access to other assets may be a prerequisite (Adhikari, Di Falco and Lovett, 2004; Coomes, Barham and Takasaki, 2004; Coulibaly-Lingani *et al.*, 2009). Landowners may find it easier than landless people to access wild resources or may be better able to make use of them, for example using leaf litter gathered in the forest to make compost for use in their crop fields. Livestock owners may have more opportunity to make use of grasslands or other ecosystems that can be grazed or from which forage can be gathered. Access to some wild products may require investment in relatively expensive equipment (e.g. boats for fishing).

Lack of time or knowledge may be constraints and there may be various physical hazards that have to be overcome (rough terrain, dangerous animals, etc.). Particularly where endangered and more valuable resources are concerned, political or social influence may affect access. Changing socio-economic conditions may alter the way in which wild biodiversity is used and valued, for example the high cultural value and therefore economic value that meat or other products from wild animals have acquired among some wealthy people in Africa and Asia (Nasi *et al.*, 2008). There may also be legal, cultural or religious factors that inhibit or promote the use of particular resources, either by the population at large or by particular sections of society.

Another concern that is sometimes raised is that while wild biodiversity is clearly a significant source of income (either regular or as a safety net) for many households, these people often remain poor. In other words, the use of wild biodiversity is not enabling them to break out of the "poverty trap" in which they find themselves and transition to other livelihood activities (Vira and Kontoleon, 2012). Moreover, overuse of wild products is a major problem in many places and has implications both for biodiversity and, in the medium term, for the sustainability of the livelihoods of people relying on these resources. The paradox is that rarity itself can give a species added value and thus promote further exploitation.

#### Social capital

"Social capital" in the context of the sustainable livelihoods framework refers to the social connections and bonds that people can draw upon for assistance. BFA can contribute to building social capital via its role in social and cultural life. It can also be the form in which social capital is realized into tangible assets. In pastoralist societies, for example, exchange of livestock via loans and gifts has traditionally been a means of building and maintaining social relationships that can later be drawn upon for help, typically again in the form of loans or gifts of animals (Morton and Meadows, 2000; Potkanski, 1999). More generally, many cultural

or religious events or activities that help to build social ties involve the use of crops, livestock, forest trees or aquatic organisms or products obtained from them. Sometimes such traditions require the use of specific varieties or breeds within species (FAO, 2007a, 2010a, 2014a, 2015a).

### Human capital

The term “human capital” is used to refer to human capacity to contribute to livelihood activities, i.e. to knowledge, skills, physical strength and so on. As discussed further in Section 2.6, BFA contributes in various ways to human nutrition, and hence to health and capacity to work. Many cultivated and wild plants have medicinal qualities. Moreover, for many households, sales of agricultural, forest or aquatic products are a means of financing expenditures on health and education. For example, among livestock-keeping households, medium-sized animals such as sheep and goats are often sold to finance educational expenses such as school fees (e.g. Otte *et al.*, 2012). Another consideration is that activities that are time consuming or physically exhausting tend to “use up” human capital, i.e. limit people’s capacity to do other things. Labour-saving assets can therefore be important. For example, in poorer households in many parts of the world, donkeys often perform essential tasks, such as carrying water and fuelwood, which would otherwise have to be done by people, often by women (Valette, 2014). Raising locally adapted species, varieties and breeds of crops, livestock, trees or fish can be less demanding in terms of labour than raising their exotic counterparts. These labour-sparing characteristics can make locally adapted genetic resources particularly important for women, who often have to spend a lot of time on child-rearing and other domestic activities (FAO, 2012a).

### Country-report analysis

Country reports from all regions, and from countries at all levels of development, provide examples of the positive contributions that BFA makes to livelihoods, including as a direct source of food and income and as a provider of ecosystem services

that underpin livelihood activities. Reported roles in food security and nutrition are described in Section 2.6. Chapter 5 includes information on the reported use of BFA in various management activities that underpin livelihoods in food and agriculture. This subsection, therefore, provides a fairly short overview of the main livelihood-related roles of BFA described in the country reports.

Direct contributions of BFA to income generation and employment are highlighted across all sectors of food and agriculture. Even in countries where these sectors make up a relatively small proportion of the national economy, BFA is reported to be key a component of the livelihoods of some local populations, whether directly or indirectly (e.g. by helping to attract tourists). Many countries report on the economic contributions provided by major food and agricultural commodities.<sup>23</sup> However, the livelihood significance of relatively “overlooked” components of BFA is also widely reported, including those that play multiple roles in household livelihoods and in the wider economy or that are of particular significance to the livelihoods of poorer sections of the population. Several countries report initiatives and programmes aiming to protect and build on the multiple benefits that BFA offers to livelihoods. Box 2.1 presents some examples.

The forest sector is widely reported as a source of employment and of a wide range of wood and non-wood forest products. For example, Bhutan mentions that over 40 species of edible wild vegetables and 350 species of edible mushrooms have been identified in its forests. It notes that as well as making a direct contribution to diets some of these wild species are sold to generate cash income. Similarly, Burkina Faso draws attention to the importance of non-wood forest products in sustaining livelihoods, particularly those of women, who are often responsible for collecting, processing and commercializing such products. Reported examples include shea butter

<sup>23</sup> Latest national data on production quantities and values for many products are available via FAO’s statistical database FAOSTAT at <http://www.fao.org/faostat/en/#home>

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– extracted from the shea tree (*Vitellaria paradoxa*) – and soubbala, a traditional aromatic condiment obtained from the seeds of the African locust bean (*néré*) tree (*Parkia biglobosa*). The Gambia notes that forests provide about 85 percent of its domestic energy requirements, in the form of fuelwood and charcoal, in addition to providing timber, wild foods, construction materials, medicine and forage for livestock. Sudan mentions that production of gum arabic (a natural gum obtained from acacia trees and used in food production and for various other purposes) makes a substantial contribution to the livelihoods of millions of its poorest people, providing some with up to 50 percent of their total cash incomes. It notes that for smallholders gum arabic represents a diversification strategy that can help to mitigate the effects of crop failure.

Fisheries and coastal ecosystems are reported to be vital to livelihoods in many countries. Fiji, for example, mentions that it has over 70 edible species of shellfish, in addition to finfish, crabs, freshwater mussels and seaweed. It notes that as well as providing a source of products that can be harvested for home consumption, some of these species (e.g. tuna) represent a significant source of paid employment and foreign exchange. India mentions the importance of mangrove ecosystems and their biodiversity in supporting coastal fisheries and hence the livelihoods of local villagers.

The country reports also highlight a range of livelihood contributions provided by livestock. Ethiopia, for example, reports that some 80 percent of smallholders in the country use animal traction to plough their fields. India reports that smallholders and landless rural dwellers manage 75 percent of the country's livestock resources and obtain nearly half of their income from them. Sudan mentions that for pastoralist groups living in areas where there are no banking services livestock are a way to store wealth. It also notes that keeping animals facilitates group solidarity in that those with larger herds may lend animals to those who have fewer resources or have been affected by droughts,

epidemics or armed conflicts. Some countries also mention the significance of beekeeping as a source of products such as honey and beeswax for home use or sale.

As illustrated by some of the examples above, many countries note the significance of wild foods to livelihoods, both in terms of food security and nutrition (see Section 2.6) and as a more general source of income. Several provide examples of the livelihood opportunities related to consumer demand for wild foods. Cameroon, for example, mentions that demand for such products from rural dwellers that have moved to urban areas or to other countries increases the prices that can be obtained for them. The popularity of *Gnetum* spp. (a forest vine eaten as a vegetable) in restaurants throughout the country and abroad is noted as a case in point. Zimbabwe reports that insects, particularly those that can be collected in large numbers, provide both a supplementary source of nutrition for local people and an income-generating activity. It notes that commercial harvesting and sale of forest insects is a substantial industry in some parts of the country and drives efforts to conserve trees that provide habitat for the targeted insects. Reports from developed countries generally indicate that wild biodiversity provides only a marginal contribution to national incomes and diets. Several, however, note that it makes a substantial contribution to the livelihoods of some sections of the population or underpins significant niche industries.

Many countries highlight the importance of biodiversity to cultural life – often particularly for indigenous populations – including via roles in traditional ceremonies, cuisine and handicrafts. Several note that aside from their purely cultural significance such traditions often also help to underpin income-generating activities, nutritious diets, the supply of medicinal products or the maintenance of social ties within communities. Niue, for example, mentions that its annual yam and thanksgiving food festivals encourage the utilization of a diverse range of local crop species and varieties and hence help promote a more nutritious diet. Almost all families in the country

## Box 2.1

**Projects and programmes supporting livelihoods by promoting biodiversity for food and agriculture – examples from around the world**

**One Village One Product (Nepal)**, a project implemented by the Ministry of Agricultural Development, is promoting indigenous food and non-food products derived from local biodiversity – including fabrics and dresses, furnishing and decorations – to enhance the livelihoods of rural villagers.

**Árbediehtu (Inherited Knowledge) (Norway)**, a project established and implemented by the Sámi University College, is documenting the traditional knowledge of the Sámi people on the management of local natural resources, including wild foods, that support their livelihoods. The aim is to integrate this knowledge into the management of local biodiversity.

**Research and Innovation in Family Agricultural Production Systems in the Ngäbe Buglé Region (Panama)** aims to document local biodiversity for food and agriculture and promote its conservation and sustainable use. Smallholders in the area are custodians of a wide variety of maize, bean, yucca and other vegetables that are well adapted to the local environment. The project has collected local crop cultivars with the aim of breeding them for characteristics such as uniform height and distributing them to family farmers. It has evaluated biofortified varieties for potential introduction in poor rural areas with the aim of improving food security and nutrition. It has also promoted the use of vermicompost in local farming systems and achieved a marked increase in crop yields.

**Mainstreaming Agro-biodiversity Conservation and Use in Sri Lankan Agro-ecosystems for Livelihoods and Adaptation to Climate Change (Sri Lanka)**, a project implemented by the Ministry of Environment and Natural Resources, Bioversity International and the Ministry of Agriculture, is looking at ways in which agrobiodiversity – including crops, forest species, livestock and pollinators – can be directly linked to sustainable production practices that can improve the livelihoods of local people while helping to increase resilience to climate change.

**Sustainable Livelihoods and Healthy Foods (Tonga)** is part of the country's Agriculture Sector Plan and aims to improve farmers' knowledge of, and access to, technology to promote climate-resilient, diversified crop and livestock production and improve product marketing.

**Forests Sustainably Managed for Communities, Environment and Shock Resilience (Forest Forces 2014–2018) (Zimbabwe)** was established with funding from the European Union and FAO to improve the food security, livelihoods and resilience of vulnerable rural communities through participatory forest management and valorization of forest products to diversify livelihood strategies.

**Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands and Timor Leste)** promotes the conservation of coastal and marine ecosystems. Objectives include protecting the livelihoods of the millions of people that depend on these ecosystems for food and nutrition and income generation.

**Mangrove Ecosystems for Climate Change Adaptation and Livelihoods (Fiji, Samoa, Solomon Islands, Vanuatu and Tonga)** targets the conservation and management of coastal mangrove ecosystems to reduce the impacts of climate change and improve the livelihoods of local communities. In addition to reducing the negative impacts of natural disasters on livelihoods, one of the project's objectives is to actively seek opportunities to obtain carbon credits for mangrove protection and reforestation in the context of REDD+ and global carbon markets.<sup>1</sup>



A typical mangrove ecosystem in Solomon Islands. © WorldFish Solomon Islands.

Sources: Adapted from the country reports of Malaysia, Nepal, Norway, Panama, Papua New Guinea, Solomon Islands, Sri Lanka, Tonga and Zimbabwe.

<sup>1</sup> <https://unfccc.int>

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are reported to participate in the latter festival, which involves a range of crops and marine species. Products are donated to village pastors and then redistributed in equal proportions to all villagers. The tradition reportedly encourages local people to grow local food species that contribute to healthy diets. Several countries note the importance of micro-organisms in the preparation of traditional foods and drinks that contribute significantly to the livelihoods of local people (see Section 5.7 for examples).

### 2.5.2 Needs and priorities

There is general agreement among reporting countries that the contributions that BFA makes to peoples' livelihoods, whether in terms of income, food security or sociocultural benefits, need to be better documented and researched. Some countries highlight the urgency of recording associated traditional knowledge that may be at risk of being lost. It is also widely recognized that efforts need to be made to ensure that the biological resources that underpin livelihoods are conserved and used sustainably, including wild resources that may be overexploited.

With regard to policies, some concerns are expressed about a lack of awareness of the livelihood significance of BFA among decision-makers and a lack of attention to the need for innovation in small-scale production systems. Some countries mention challenges related to the need to reconcile conflicts between conservation-focused and livelihood-focused policies. Policy areas identified as having potential for further development in support of the livelihood roles of BFA include marketing – including certification schemes (e.g. fair trade, geographic indication or organic production) for products that can fetch premium prices, including in export markets – and agro-ecotourism.

## 2.6 Food security and nutrition

- Biodiversity for food and agriculture (BFA) contributes to food security and nutrition in many ways, including by enabling food to be produced in a wide range of

environments, helping to maintain the stability of food supplies through the year and through shocks such as droughts and pest outbreaks, supplying a wide variety of nutritionally diverse foods and contributing to the supply of water and fuel used in food preparation.

- Wild biodiversity is an important source of food for many people, particularly in the poorer regions of the world. It also provides raw material for crop breeding programmes and contributes to the supply of many ecosystem services that support food production.
- Actions that need to be taken to strengthen the contributions of BFA to food security and nutrition include:
  - taking steps to maintain and restore ecosystems and habitats of importance to food and agriculture;
  - promoting the sustainable use and conservation of relevant species and populations;
  - implementing breeding programmes targeting, *inter alia*, nutrient content and adaptation to environmental stresses and shocks, particularly those associated with climate change; and
  - increasing knowledge of how BFA, including wild foods, supports the various dimensions of food security.

Ending food insecurity and malnutrition remains one of the most fundamental challenges facing the world. Recent figures signal a rise in world hunger levels, reversing a long downward trend (FAO *et al.*, 2018). According to the latest estimates, about 821 million people in the world are chronically undernourished, up from 804 million in 2016 (*ibid.*). Estimates using the Food Insecurity Experience Scale, a more complex and multidimensional measure of food insecurity, show that about 769 million people in the world faced severe food insecurity in 2017. In the same year, nearly 151 million children under five years of age suffered from stunted growth, while 50 million suffered from wasting (a low weight-for-height ratio). Over 38 million children under five were estimated to be overweight and more than 672 million adults to be suffering from obesity (*ibid.*).

The widely used definition adopted by the 1996 World Food Summit states that food security