COUNTRY REPORTS

THE STATE OF **INDIA'S** BIODIVERSITY FOR FOOD AND AGRICULTURE

	منظمة الأغذية والزراعة للأمم المتحدة	联合国粮食及农业组织	Food and Agriculture Organization of the United Nations	Organisation des Nations Unies pour l'alimentation et l'agriculture	Продовольственная и сельскохозяйственная организация Объединенных Наций	Organización de las Naciones Unidas para la Alimentación y la Agricultura

Guidelines for the preparation of the Country Reports for *The State of the World's Biodiversity for Food and Agriculture*

November 30, 2013

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Country:	India
National Focal Point:	Department of Agricultural Research and Education, Ministry of Agriculture and Farmers Welfare, Government of India

INSTRUCTIONS FOR DYNAMIC GUIDELINES

How do I complete the dynamic guidelines?

1. You will require Adobe Reader to open the dynamic guidelines. Adobe Reader can be downloaded free of charge from: http://get.adobe.com/uk/reader/otherversions/. Use Adobe Reader Version 10 or higher.

2. Open the dynamic guidelines and save it (save as -> pdf) on your hard drive.

3. Please rename it <name of your country>.pdf.

4. You may forward the dynamic guidelines to stakeholders you would like to involve or inform by e-mail. You may also print and/or save the dynamic guidelines.

5. It is advisable to prepare textual responses (including any formatting such as bullet points) first in a separate document and then to copy and paste them into the form. Please use font Arial 10. Acronyms and abbreviations should be avoided if possible. If included, they must be introduced (i.e. written out in full) the first time they are used. Note that the text boxes are expandable. Once text has been entered, the box will automatically enlarge to make its content fully visible when you click outside its border.

6. When you have finished completing the dynamic guidelines, click the "Submit by Email" button on the last page and send the completed dynamic guidelines to SOW-BFA@fao.org. This should automatically attach the document to an email that you can then send. Otherwise, please attach the completed dynamic guidelines manually to an e-mail and send it to SOW-BFA@fao.org. A letter confirming official endorsement by relevant authorities should also be attached to the email.

7. You will receive a confirmation that the submission was successful.

Where can I get further assistance?

Should you have any questions regarding the dynamic guidelines, please address them by e-mail to SOW-BFA@fao.org.

How, by whom and by when must the completed dynamic guidelines be submitted?

Once officially endorsed by the relevant authorities, the completed dynamic guidelines should be submitted (click the "Submit by Email" button on the last page) by the National Focal Point. Completed dynamic guidelines should be sent **by December 31st, 2014**.

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THE ESSENTIAL ROLE OF COUNTRY REPORTS

The preparation of Country Reports is one of the most important steps in the process for preparing the first report on *The State of the World's Biodiversity for Food and Agriculture* (the SoWBFA Report), and will be critical in filling in gaps to existing information and establishing baseline information on biodiversity for food and agriculture, and on its role in providing multiple ecosystem services. The preparatory process of Country Reports should also be considered a strategic planning exercise and the report generated an overview of the country's sustainable management practices of biodiversity for food and agriculture and a tool for the assessment of national priorities and future needs to be addressed. Country Reports should also be seen as an opportunity to engage and stimulate the interests of a wide range of stakeholders from different sectors, and including smallholders.

The present Guidelines for Country Reports (Guidelines) aim to help countries to assemble baseline information and highlight the importance of a collaborative process, bringing together experts (including those stakeholders with experiential knowledge, such as farmers, pastoralists, forest dwellers and fisher folk) across sectors to assess available information and analyze gaps and needs. The Guidelines are also structured as a tool to guide data collection, planning and policy making at national level.

The Guidelines make a distinction between information countries may wish to provide in support to their own strategic planning, from the information needed for the preparation of the overall SoWBFA report. Countries may wish to draw upon documents prepared for the various sector State of the World's Reports for their cross-sectoral synthesis.

I. INTRODUCTION

1. The FAO Commission on Genetic Resources for Food and Agriculture (the Commission) is the only intergovernmental forum which specifically deals with the whole range of genetic resources for food and agriculture. Genetic resources for food and agriculture are the building blocks of biodiversity for food and agriculture. The mandate of the Commission covers all components of biodiversity for food and agriculture. To implement its broad work programme and to achieve its objectives through a planned and staged approach, the Commission adopted and subsequently revised and updated its Multi-Year Programme of Work (MYPOW). CGRFA-14/13/Report, *Appendix I*, Table 1.

2. One of the major milestones of the MYPOW is the presentation of the first report on *The State of the World's Biodiversity for Food and Agriculture* (the SoWBFA Report) to the Commission's Sixteenth Regular Session (to be held in 2017) and the consideration of follow-up to the SoWBFA Report, including through a possible Global Plan of Action. The SoWBFA Report will also be a major milestone in the context of the United Nations Decade on Biodiversity.

3. The Commission requested FAO, at its Eleventh Regular Session in 2007, to prepare the SoWBFA report, for consideration at its Sixteenth Regular Session, following a process agreed upon by the Commission. CGRFA-11/07/Report It stressed that the process for preparing the SoWBFA Report should be based on information from Country Reports and should also draw on thematic studies, reports from international organizations and inputs from other relevant stakeholders, including centres of excellence from developing countries. CGRFA-14/13/Report, paragraph 14.

4. The Commission stressed that the SoWBFA Report should focus on the interactions between sectors and on cross-sectoral matters, taking full advantage of existing information sources, including sectoral assessments. It also suggested that priority be given to key supplementary information not available in existing sources. CGRFA-14/13/Report, paragraph 14.

5. The Commission acknowledged that the report's findings would be preliminary and incomplete in a number of areas and requested FAO to ensure that such information gaps would be assessed and highlighted in the report. It also requested FAO to

include in the report lessons learned and success stories on the conservation and sustainable use of biodiversity for food and agriculture. CGRFA-14/13/Report, paragraph 15.

6. The SoWBFA Report will provide a baseline analysis of the state of knowledge. Incompleteness and gaps in available information should be clearly identified and acknowledged and used to direct future assessments. In compiling information for their Reports countries should state clearly where information is not available on specific subject areas.

7. The present Guidelines for the preparation of Country Reports contributing to the SoWBFA Report present an overall approach and a set of objectives that can guide the preparation of Country Reports, the scope of the report and the structure that can be used, as well as an appropriate timeline and process for their preparation.

8. The Guidelines assist countries to provide information complementary to sector reports in order to address the following questions:

- What is the state of the conservation and use of biodiversity for food security and nutrition, ecosystem services and sustainability?
- What trends can be identified in the conservation and use of biodiversity for food and agriculture and in the effects of major drivers of change?
- How can conservation and use of biodiversity for food and agriculture be improved and the contributions of biodiversity to food security and nutrition, ecosystem services, sustainability and the improvement of livelihoods of farmers, pastoralists, forest dwellers and fisher folk be enhanced?

9. Major differences exist between countries with respect to the nature, conservation and use of biodiversity for food and agriculture. To provide baseline information, highlight knowledge gaps and to facilitate the regional and global synthesis of the information countries are therefore invited to follow the structure provided in the Guidelines as closely as possible in the preparation of their Country Report.

II. OBJECTIVES OF THE GUIDELINES

10. These Guidelines have been prepared by FAO to assist in the preparation of Country Reports contributing to the SoWBFA Report. The Guidelines have been designed to assist countries to undertake a strategic assessment of their biodiversity for food and agriculture, with particular emphasis on components of biodiversity for food and agriculture that are not traditionally considered by the other sectoral assessments and yet contribute to the livelihoods of smallholder communities. These include uncultivated or wild food and non-food products, as well as species of importance to production systems.

III. SCOPE, STRUCTURE AND CONTENT

Scope of the Country Report

11. The scope of the Country Reports includes the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels that sustain the structures, functions and processes in and around production systems, and that provide food and non-food agriculture products. A detailed description of the scope of the Country Report is provided in Annex 1. Production systems, as defined for the purposes of this report, include the livestock, crop, fisheries and aquaculture, and forest sectors (description provided in Annex 2).

12. The present Guidelines for the Country Report mainly focus on those areas not covered by sectoral reports, e.g. the biological diversity associated with different supporting and regulating ecosystem services within production systems or of importance to them, referred to hereinafter as associated biodiversity, as well as wild resources used for food. In addition to this, countries that previously presented or are currently preparing a Country Report on Plant, Animal, Aquatic or Forest Genetic Resources may wish to integrate information from these reports in the preparation of their Country Report for the SoWBFA.

13. The Guidelines should help countries to provide information from an ecosystem perspective, including on the provision of ecosystem services, and on the implementation of an ecosystem approach. They will also assist countries to report on the use of biodiversity for food and agriculture for food security and nutrition, rural livelihoods, sustainability and sustainable intensification as well as on relevant gender perspectives. In this way, the Guidelines will assist countries in describing the multiple functions and the multiple values to producers and users of biodiversity for food and agriculture.

Structure of the Country Report

14. An Executive Summary is recommended, along with a section providing an Introduction to the Country, which would

provide a description of the country and an overview of the different sectors.

15. Country Reports should follow as closely as possible the structure of the SoWBFA Report as presented in CGRFA-14/13/3 Appendix 1, which includes the following Chapters:

Chapter 1: Introduction
Chapter 2: Drivers of change
Chapter 3: The state and trends of biodiversity for food and agriculture
Chapter 4: The state of use of biodiversity for food and agriculture
Chapter 5: The state of interventions in the conservation and use of biodiversity for food and agriculture
Chapter 6: Future agendas for conservation and sustainable use of biodiversity for food and agriculture

16. An analysis of the different ways in which biodiversity for food and agriculture is used and supports cultural, social and economic values of local communities and traditional peoples will be an important aspect of the SoWBFA Report and of Country Reports. The Country Reports should therefore take full account of these aspects and seek the involvement of the widest range of stakeholders. In this respect, it is recommended that the scope of activities includes actions being taken by the public, private and nongovernmental sectors, and takes account of gender perspectives, and the needs, priorities and perspectives of indigenous peoples and local communities through their organizations.

IV. TIMELINE AND PROCESS

17. In line with the overall process, as established by the Commission, the Director-General of FAO sent a Circular State Letter on 10 June 2013 to countries requesting them to identify National Focal Points for the preparation of Country Reports by November 30, 2013, and invited countries to submit their Country Reports no later than 31 December 2014.

18. The following steps are recommended in preparing the Country Report, using a participatory approach:

- Each participating country should appoint a National Focal Point for the coordination of the preparation of the Country Report who will also act as focal point to FAO. National Focal Points should be communicated to Ms Linda Collette, Secretary, Commission on Genetic Resources for Food and Agriculture (cgrfa@fao.org), by November 30, 2013.
- Countries are encouraged to establish a national committee to oversee the preparation of the Country Report. Given the cross-sectoral nature of the Country Report, the national committee should consist of as many representative stakeholders as practical (representing government, research and civil society) including from different sectors (fisheries and aquaculture, forest, livestock and plants) and those able to support analysis of associated biodiversity. It is recommended that the national committee also include a gender specialist along with someone who can contribute to economic issues, with a natural resource management, environmental economics, or other relevant background. It is recommended that within the 13 months countries are given for the preparation of the Country Report, the national committee meets frequently to review progress and consults widely with key stakeholders.
- The national committee may find it useful to establish cross-sectoral and inter-departmental/inter-ministerial working groups to compile data and information for specific sections of the Country Report, or to write specific chapters of the Country Report.
- The National Focal Point should coordinate the preparation of the first draft of the Country Report, which should be reviewed by the national committee. The National Focal Point should facilitate a consultative process for broader stakeholder review, including stakeholders from various ministries, departments, NGOs, research institutions, and stakeholders with experiential knowledge, such as farmers, pastoralists, forest dwellers and fisher folk, etc.
- Following the stakeholder review, the National Focal Point should coordinate the finalization of the Country Report, submit it to the government for official endorsement and transmit it to FAO in one of the Organization's official languages (Arabic, Chinese, English, French, Russian and Spanish) by 31 December 2014. The Country Report will be an official government report.
- If countries are unable to submit final Country Reports by the set deadline, preliminary reports of findings should be provided to FAO to contribute to the identification of global priorities for inclusion in the SoWBFA Report.

The FAO contact for the preparation of Country Reports is:
Secretariat
Commission on Genetic Resources for Food and Agriculture
Food and Agriculture Organization of the United Nations
Viale delle Terme di Caracalla
00153 Rome, Italy
Fax: +39 0657055246
Email: SOW-BFA@fao.org

V. DETAILED METHODOLOGY AND GUIDANCE BY CHAPTER

The guidelines outline the suggested content and provide questions to assist countries to undertake their strategic analysis and develop each section of their Country Report. The questions are provided to facilitate analysis, to stimulate discussion and to ensure that the Country Report contains strategic directions that address priorities and needs. Questions that are critical to enable basic understanding of the conditions in your country and facilitate regional and global synthesis of the data and information collected are indicated in **bold**. Please try to ensure that data and information are provided for these questions wherever such information is available.

Questions are organized and formulated in relation to the production systems that are present in your country. Thus it is very important to fill in Table 1 in the Introduction to establish a list of production systems that will be used throughout the Guidelines.

EXECUTIVE SUMMARY

It is recommended that the Country Report contains an executive summary of 2-3 pages highlighting the main findings of the analysis and providing an overview of key issues, constraints and existing capacity to address the issues and challenges. The executive summary should indicate trends and driving forces and present an overview of the proposed strategic directions for future actions aimed at the national, regional and global levels.

India is located in the northern hemisphere between 8degrees 4' to 37degrees 6'N latitude and 68degrees 7' to 97degrees 25' E longitude; about 3,214 km from north to south and about 2,933 km from east to west; covers an area of 32,87,263 sq. km. India accounts for only about 2.4 % of the world's geographical area and 4 % of its water resources, but has to support about 17 % of the world's human population and 15 % of the livestock. India is known as one of the megadiverse countries and harbours 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals on only 2.4% of the world's land area. The country has developed a biogeographic classification for conservation planning, and has mapped biodiversity-rich areas within the country. Of the 34 global biodiversity hotspots, four are present in India, represented by the Himalaya, the Western Ghats, the North-east, and the Nicobar Islands. Considering the outstanding universal values and exceptionally high levels of endemism in the Western Ghats in the States of Kerala, Karnataka, Tamil Nadu and Maharashtra have been inscribed on the United Nations Education Scientific and Cultural Organization (UNESCO) World Heritage List in 2012.

Presently, the Indian diversity is composed of rich genetic wealth of native as well as introduced types. Crop diversity is well represented as developed cultivars, landraces or as folk varieties in different phytogeographical regions of India. In situ conservation of Plant Genetic Resources (PGR) forms an integral part of the biodiversity conservation programmes in India. Fourteen Biosphere Reserves have been designated of which four are included in the World Network of Biosphere Reserves. There are 92 National Parks and 500 wildlife sanctuaries in the country covering an area of 15.67 m ha. Several difficult areas were explored during last five years and rare/endemic/ endangered species were collected. Efforts have been made for documentation and protection of indigenous technical knowledge and also the germplasm of the local landraces/ farmers' varieties.

Agriculture faces the unprecedented challenge of securing food supplies for a rapidly growing human population, while seeking to minimize adverse impacts on the environment. Recent reports indicate that crop growth and yield are adversely affected by abiotic and biotic factors including weather (rain, heat and temperature), soil conditions (water, pH and nutrients), insect populations, disease incidence and management practices (cultivar, irrigation, fertilization and rotation). These factors represent the principal cause of crop failure, decreasing average yields for major crops. Salinity is one of the most devastating environmental stresses, which causes major reductions in cultivated land area, crop productivity and quality. It has been estimated that an approximate area of 7 million hectares of land is covered by saline soil in India. Most of this occurs in indo-Gangetic plains that covers the states of Punjab, Haryana, Uttar Pradesh, Bihar and some parts of Rajasthan. Arid tracts of Gujarat and Rajasthan and semi-arid tracts of Gujarat, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh are also largely affected by saline lands. It is also predicted that the salinized areas are increasing at a rate of 10% annually due to low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices etc.

Changes in biodiversity are driven by combinations of drivers that work over time, on different scales, and that tend to amplify each other. For example, population and income growth combined with technological advances can lead to climate change. They have affected species distributions, population sizes, and the timing of reproduction or migration events, as well as the frequency of pest and disease outbreaks. Projected changes in climate by 2050 could lead to the extinction of many species living in certain limited geographical regions. The Intergovernmental Panel on Climate Change (IPCC) project that the average

surface temperature will rise by 2 to 6 degrees centigrade by 2100 compared to pre-industrial levels. This is expected to cause global negative impacts on biodiversity. Exposure to one threat often makes a species more susceptible to a second, and so on, multiple threats may have unexpectedly dramatic impacts on biodiversity.
Many alien terrestrial and aquatic weeds have entered into India accidentally. These weeds cause enormous direct or indirect losses to ecosystems and threaten biodiversity and water availability. Some of the most important noxious weeds of alien origin in India are Salvinia molesta D. Mitch., Eichhornia crassipes (C. Martius) Solms-Laub. and Alternanthera philoxeroides (C. Maritus) Griseb. among aquatic weeds, and Opuntia spp., Lantana camara L., Ageratina adenophora (Sprengel) K. and R., Chromolaena odorata (L.) K. and R., Parthenium hysterophorus L., Acacia melanoxylon R. Brown, Mikaniamicrantha H.B.K. and Prosopis juliflora (Sw.) DC. among terrestrial weeds. Most of these weeds have occupied such niches where chemical or mechanical control measures are neither feasible nor economical. They include forest areas, tea, rubber and other plantation crops, vacant or grazing areas and water bodies. Invasive species have serious economic and environmental implications across a range of ecosystems especially agro-ecosystems. Several countries have suffered enormous losses due to the inadvertent introduction of invasive alien species of pests along with transboundary movement of planting material of crops. Several pests were introduced on various crops in India too which have since become serious pests and continue to cause damage year after year for example The fluted scale (Icerya purchasi), a serious pest of citrus and native of Australia was introduced into India before 1928 from Sri Lanka probably on wattles (Acacia sp.) to later become a serious pest on citrus in south India. A large-scale campaign was organized in south India from 1946 to 1950 to check the spread of this pest.
Major gaps in information and knowledge with respect to the impact and response to natural or human-made disasters and biodiversity for food and agriculture are inadequate awareness and education; lack of databases about the effect of disaster, early warning system and impact assessment. Capacity or resources limitations include inadequate funds, insufficient resources/infrastructure for mitigation, inadequate credit and insurance support and lack of legal support. The policy and institutional constraints are due to slower response post disaster/unorganized response, inadequate credit and Insurance support and lack of legal support. The priorities and action required are assessing AnGR diversity after disaster, compensation and insurance for the losses, awareness programmes and legal support system.
Planned actions and future priorities with respect to implementing ecosystem approaches for the various components of biodiversity for food and agriculture are envisaged and priorities may be decided based on the quantum of genetic diversity and eco-geographical fragility of areas, for instance, NEH states, NW Himalayas, and Western Ghats. Most appropriate sites including gene sanctuaries, national parks and forest reserves as hotspots for conservation of CWR diversity are to be identified. Neglected and underutilized species to be integrated in the crops growing models in general and eco-geographically fragile areas in particular to in the eventualities of radical environmental stresses (stochastic events). Documentation of information on landraces and crops that survive stochastic events as they are likely to be well adapted to the particular stress, and future generations may possess that adaptation.

Modalities to repatriate the diversity in disaster situations in the event of large scale diversity loss in reference region need to be put in place. The infestation of invasive aliens and ingenious notorious weeds and weedy species in and around the close proximity of cultivated crops, adjoining agro-forestry systems, disturbed and semi-cultivated habitats around farmlands owing to their richness in crop wild relatives' diversity needs to be minimised. Afforestation activities of crop wild relatives in the habitats of their occurrence through in-situ seeding and planting to be encouraged. The live germplasm resource centers will allow harnessing dual potential in conservation and aquaculture diversification. The material raised in the process will be used for stock enhancement, rehabilitation in wild and ensuring that genetic make up of respective species in the wild is not altered. Greater efforts towards capacity development of stakeholders including state fisheries department officials and fisher folks will lead to enhanced implementation of ecosystem based approach in various aquatic production systems.

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CHAPTER 1: Introduction to the Country and to the role of biodiversity for food and agriculture

Proposed structure of the chapter and information to be included in the Country Reports

The first objective of this Chapter is to present an overview that will help the reader appreciate the context for the Country Report by providing a general overview and summary of the features, demographics and major trends in overall biodiversity for food and agriculture in the country. Explicit attention should be given to associated biodiversity, ecosystem services and wild foods.

Countries that previously presented or are currently preparing a Country Report on Forest, Aquatic, Animal or Plant Genetic Resources, should be able to use some of the background information contained in these reports to prepare parts of their introductory section.

In this Chapter, countries will create a list of their different production systems that will be frequently referred to in subsequent chapters.

This chapter will seek information on the following topics:

- Basic information on the size and location of the country; its main physiographic and climatic features; human population;
- A synthesis of the current situation with respect to the current and potential contribution of biodiversity for food and agriculture to food security and nutrition, ecosystem health and sustainability of production systems, as supported by associated biodiversity and ecosystem services. Specific attention is also given to wild foods;
- Description of the different production systems within the country, as well as an overview of their importance to the national economy and rural livelihoods.

Preparation of the Country Report

1. Provide a description of the process that was followed in preparing the Country Report, preferably providing the names (with affiliations and addresses) of the participants, including all stakeholders consulted.

At the Regional Consultation on the State of Asia's Biodiversity on Food and Agriculture held from April 26-28, 2015 in Bangkok, Thailand ,representative from India participated to initiate the process of preparation of the country report. The preparation of the country report followed the process of designation of national focal point which is Department of Agricultural Research and Education, Ministry of Agriculture and Farmers Welfare, Government of India under the guidance of Dr Jeet Singh Sandhu, Deputy Director General, Crop Sciences Division, Indian Council of Agricultural Research. All the stakeholders were consulted and briefed about the guidelines and other documents for the preparation of the country reports. National institutes dealing with genetic resources of plants, animals, insects, microorganisms, fish and soil sciences were contacted for providing the updated information as the guidelines provided by Commission on Genetic Resources for Food and Agriculture. These are the National Bureau of Plant Genetic Resources (NBPGR), the National Bureau of Animal Genetic Resources (NBAGR), the National Bureau of Agriculturally Important Microorganisms (NBAIM), National Bureau of Insect Genetic Resources and the National Bureau of Fish Genetic Resources (NBFGR).

The data was collected from reports of India's fifth country report submitted to CBD, National Agricultural Innovation Project reports, Hand book of agriculture, Indiastat, websites of ministry of environment, forest and climate change, department of agricultural cooperation and farmers welfare, WFCC, Botanical Survey of India, Annual reports of ICAR Network project on 'Application of Microorganisms in Agriculture and allied Sectors''; published literature in peer reviewed journals.

List of contributors
ICAR-NBPGR: Dr. Pratibha Brahmi, Principal Scientist &OIC Germplasm Exchange Unit; Dr. J.C.Rana, Head, Germplasm Evaluation Division; Dr. Veena Gupta, Principal Scientist; Dr. Kavita Gupta, Principal Scientist; Dr. Vandana Tyagi, Principal Scientist; Dr. S.K.Yadav, Principal Scientist; Dr. K. Pradeep, Senior Scientist and Dr. Anitha Pedapati, Scientist.

ICAR-NBAGR: Dr. Arjava Sharma, Director; Dr. P.K. Singh, Principal Scientist; Dr. R. K. Pundir, Principal Scientist; Dr. Manishi Mukesh, National Fellow; Dr. Vikas Vohra, Senior Scientist and Dr S. K. Niranjan, Senior Scientist.

ICAR-NBFGR: Dr. J.K. Jena, Deputy Director General (Fisheries Science), Indian Council of Agricultural Research and Dr. Kuldeep K. Lal, Director.

ICAR-NBAIR: Dr. Chandish Ballal, Director.
ICAR-NBAIM: Dr. Anil Kumar Saxena, Director; Dr. Susheel Kumar Sharma, Principal Scientist.

General overview of the country

2. In a few paragraphs, provide a synthetic overview of your country, including the size, location, main physiographic and climatic features. Include a section on human population, providing disaggregated data on women and men contribution and involvement in agriculture. Briefly discuss as well the overall nature and characteristics of the economy, including the contribution of the different sectors. You may wish to draw upon the country overviews provided in the first chapters of previous and ongoing Country Reports on Forest, Aquatic, Animal or Plant Genetic Resources.

Plants
India is located in the northern hemisphere between 8 degrees 4' to 37 degrees 6'N latitude and 68degrees 7' to 97degrees 25' E longitude; about 3,214 km from north to south and about 2,933 km from east to west; covers an area of 32,87,263 sq. km. India accounts for only about 2.4 % of the world's geographical area and 4 % of its water resources, but has to support about 17 % of the world's human population and 15 % of the livestock.
India is known as one of the megadiverse countries and harbours 7-8% of all recorded species, including over 45,000 species of plants and 91,000 species of animals on only 2.4% of the world's land area (Annonymous 2014). The country has developed a biogeographic classification for conservation planning, and has mapped biodiversity-rich areas within the country. Of the 34 global biodiversity hotspots, four are present in India, represented by the Himalaya, the Western Ghats, the North-east, and the Nicobar Islands. Considering the outstanding universal values and exceptionally high levels of endemism in the Western Ghats in the States of Kerala, Karnataka, Tamil Nadu and Maharashtra have been inscribed on the United Nations Education Scientific and Cultural Organization (UNESCO) World Heritage List in 2012 (Annonymous 2014). Besides the recognized hot spots like Western Ghats and Northeastern hill region, India is endowed with other rich biodiversity locales like the Bastar region inhabited by tribals, Andaman and Nicobar Islands, the mangrove forests of Sunderbans, wet evergreen rain forest of Kerala, playas of Rajasthan, Chilka lake in Orissa, Sonar Lake of Maharashtra, thermal springs in the Central Himalayan region, that are abode to large unexplored microbial diversity and is home to diverse microbes, many of them being unique. (Bhattacharjee and Joshi 2014) Being one of the 17 identified megadiverse countries, India has 10 biogeographic zones and is home to 8.58% of the mammalian species documented so far, with the corresponding figures for avian species being 13.66%, for reptiles 7.91%, for amphibians 4.66%, for fishes 11.72% and for plants 11.80% (Varghese et al. 2009; Singh and Banyal 2014). The fertile plains of Indo-gangetic Plains (IGP), Central India, plateau of Deccan, chota Nagpur, Ran of Kacch, the coastal shallow areas, the cold deserts of Leh and Ladakh etc., and forest ecosystems provide other diversity-rich spots yet to be exploited and conserved. Understanding and exploring microbial diversity will lead to judicious and gainful utilization of this nature's treasure.
The rich biodiversity resource includes about 194171 microorganisms (WFCC, 2016) including bacteria, fungi and actinomycetes conserved in 18 MRCs so far. The biodiversity includes about 850 bacterial/viral species, 7175 species of algae including 1453 species of cyanobacteria, 14500 species of fungi and 2223 species of lichens (BSI 2009). Watve et al (1999) observed a plausible estimate of several fold higher myxobacterial diversity in India than the species recorded worldwide so far. They reported 8 novel myxobacterial types out of 32 species described in Bergey's Manual of Determinative Bacteriology.

Livestock
Agriculture is an important sector of the Indian economy, accounting for 14% of the nation's GDP, about 11% of its exports, about half of the population still relies on agriculture as its principal source of income and it is a source of raw material for a large number of industries. Livestock products are the major source to ensure food and nutritional security to millions of people. The value of output from livestock sector at current prices during 2011-12 has been estimated as Rs. 4590.50 billion, which includes Rs. 3054.8 billion from milk group, Rs. 836.4 billion from meat group, Rs. 178.03 billion from egg, Rs. 4.52 billion from wool and Rs. 318.5 billion from dung.

Aquaculture
India is bestowed with vast and diverse aquatic resources including 8,118 km coast line, 2.414 m ha ponds and tanks, 1.3 m ha beels, ox-bow lakes and swamps, 2.9 m ha reservoirs, 195,210 km rivers and canals, and 1.24 m ha of potential area for brackishwater aquaculture. The Ganga, Brahmaputra, Indus, Mahanadi, Godavari, Krishna, Cauvery, Narmada and Tapti are the important rivers, which contribute bulk of inland capture fisheries production in the country and also hold rich fish biodiversity. The country harbours 4 out of 34 biodiversity hotspot areas of the world. The country is fortunate to possess vast and varied fish genetic resources in different aquatic ecosystems, which includes 3,398 finfish species (1887 marine fishes, 936 freshwater fishes, 113 brackish water fishes and 462 exotic fishes) and account about 10% of the world finfish diversity. The total fish production of the country during 2014-15 was over 10.0 mmt, of which 3.5 mmt was contributed by the marine sector and 6.5 mmt was by the inland sector. The export value of fish and fish products of the country during 2014-15 was as much as US$ 3.5 billion.

Microbes

The extent of environmental degradation and its effect on agriculture as a consequence of anthropogenic activities and physical evolution is well known through the effects of land, air and water pollution, coal, oil and mineral extraction, land management disturbance, deforestation, urbanization and global warming. It is of great concern that how and to what extent such environmental degradation affects microbial abundance and species richness. Therefore, cataloguing and preservation of microbial flora showing significance towards agriculture, become necessity of the present time for judicious microbial resource management, bio-prospecting and fundamental scientific research. The Microbial Resource Centres (MRCs) are playing vital role in mapping, documenting, conserving and prospecting the use of these live treasures for the benefit of mankind. They are regarded as service providers and repositories of living cells, genomes of organism, and information relating to phylogeny and the functions of biological systems. Normally a MRC contain collections of culturable microorganisms, viable but not yet culturable organisms, cells and tissues, as well as databases containing molecular, physiological and structural information relevant to these collections.

Microbial germplasm represents living microbial entities (bacteria, actinomycetes, archea, cyanobacteria, fungi, viruses etc.) available in different habitats in its original life-form on the earth. These life forms and their communities are the most viable, dynamic and live unseen natural creatures that reflect the original state-of-the-art lively condition of every habitat including the soil, water, air, sediments as well as plants, animals including humans and microbes themselves (microbiome). Every natural soil and water habitat including normal, sub-normal or extremes as well as living things contains vast populations of microscopic microbial communities present in a state of dynamic equilibrium and changing balances. All such microbial communities compete with each other and the environment for their food, space and finally survival and therefore, any change in the environmental conditions such as food supply, temperature, moisture, oxygen supply and other biotic and abiotic pressure can result in changes which cause one or many types of microbes to become temporarily or permanently dominant or eliminated over the others.

Role of biodiversity for food and agriculture

Countries that previously presented or are currently preparing a Country Report on Forest, Aquatic, Animal or Plant Genetic Resources, should be able to use some of the background information contained in these reports to prepare this part of their introductory section. Detailed information on associated biodiversity, ecosystem services and wild foods will be provided in chapters 2, 3, 4, and 5 of the Country Report, and thus, countries may wish to consider developing this section after completing the main body of the Country Report.

3. Provide a summary of the role of biodiversity for food and agriculture in improving food security and nutrition, the livelihoods of farmers, pastoralists, forest dwellers and fisher folk, ecosystem health and sustainability of production systems in your country. Specific attention should be given to associated biodiversity, ecosystem services and to wild foods. The summary should also draw attention to the *ex situ* and *in situ* conservation of biodiversity for food and agriculture, the most significant aspects of use to improve food security and nutrition in the country, major changes observed in the last 10 years and the main factors causing changes. Significant risks or dangers to the conservation and use of biodiversity for food and agriculture may also be highlighted.

Crops

Agriculture in India has an extensive background which goes back to ten thousand years. At present, India holds the second position in the world in agricultural production. It also contributes a major share in the Gross Domestic Product (GDP) of the country. In addition, the sector recruits about 50% of the entire manpower.

Regardless of the fact that there has been a gradual slump in its contribution to GDP of the country, agriculture is currently the biggest industry in India. On the whole, it plays a key role in the socioeconomic growth of the country.In terms of agricultural contribution, some of the most developed states in India are:Punjab, Uttar Pradesh, Madhya Pradesh, Haryana, Bihar, Andhra Pradesh, Maharashtra, West Bengal, Gujarat. All these states play a key role in the agrarian development of India.

The total arable territory in India is 15,73,50,000 km2, which represents about 52.92% of the overall land zone of the country. Arable land in India is diminishing because of continuous strain from an ever-increasing number of inhabitants and growing urbanisation.

1. kharif, rabi and zaid. Some specific crops are only grown during a particular season, for instance, rice is a kharif crop and wheat is rabi crop.

There are certain problems and challenges faced by the agriculture sector in India. Some of these are long-standing and some are emerging due to the ongoing agricultural practices.

India ranks first in producing the following agricultural outputs: Anise, Fresh fruit, Badian, Fennel, Tropical fresh fruit, Coriander, Pigeon peas, Jute, Spices, Pulses, Castor oil seed, Millets, Safflower seeds, Sesame seeds, Limes, Lemons, Dry chillies and

peppers, Cow's milk, Cashew nuts, Chickpeas, Ginger, Okra, Guavas, Turmeric, Goat milk, Mangoes, Meat, Buffalo milk. In addition, the country also ranks as the top producer of millets such as Bajra, Jowar, and Ragi. In terms of rice production, India holds the second position after China.

India produces about 10% of the fruits produced in the world. The country holds the first position in the world in producing the following fruits: Papaya ,Mangoes, Sapota, Banana.
India also holds a high rank in the world in the production of the following:Sorghum, Tobacco, Coconuts, Rapeseed, Tomatoes, Hen's eggs.

India ranks sixth in the world in the production of coffee. India has the biggest number of livestock in the world. India also ranks high as the producer of the following:Cabbages, Cashews, Fresh vegetables, Cotton seed and lint, Brinjal, Garlic, Silk, Goat meat, Cardamom, Nutmeg and Mace,Wheat, Onions, Sugarcane, Rice, Dry beans, Lentil, Tea, Groundnut, Cauliflowers, Green peas, Pumpkins, Potatoes, Gourds, Squashes, Inland fish

The population of India is increasing at a faster pace than its capacity to produce wheat and rice.

India holds the second position in the production of wheat, rice, cotton, sugarcane, and groundnuts. It is also the second biggest harvester of vegetables and fruits, representing about 9% and 10% of the overall vegetable and fruit production in the world respectively.
The country is the top producer of jute, milk, and pulses and holds the second rank in the production of silk and is also the biggest consumer of silk in the world.

In a huge country like India, the necessary extent of outlay for the expansion of merchandising, warehousing, and cold storage arrangement is expected to be massive.

The Government of India has been earnestly trying to put into operation different plans to increase investment or outlay in merchandising and commercialising. Some of the known plans and strategies of the Indian government include the following: Market Research and Information Network, Construction of Rural Godowns, Grading and Standardisation, Development/ Strengthening of Agricultural Marketing Infrastructure

The Indian Council of Agricultural Research (ICAR) is the principal authority in farming and ancillary industries, which comprise learning and research. The post of the President of the ICAR is held by the Union Minister of Agriculture. The Indian Agricultural Research Institute (IARI) was set up in the year 1905. The institute played a key role in the studies and explorations that resulted in the Green Revolution in the 1970s. IARI formulates new methods for the planning of agricultural testing. It also evaluates information associated with cultivation and offers expert advice in statistical methods for livestock and cultivation of trees. Of late, the Government of India has established Farmers Commission to fully assess the cultivation plan. Nonetheless, the suggestions received varied responses.

Presently, the Indian diversity is composed of rich genetic wealth of native as well as introduced types. Crop diversity iswell represented as developed cultivars, landraces or as folk varieties in different phytogeographical regions of India.In situ conservation of Plant Genetic Resources (PGR) forms an integral part of the biodiversity conservation programmesin India. Fourteen Biosphere Reserves have been designated of which four are included in the World Network of BiosphereReserves. There are 92 National Parks and 500 wildlife sanctuaries in the country covering an area of 15.67 m ha. Severaldifficult areas were explored during last five years and rare/endemic/ endangered species were collected. Efforts havebeen made for documentation and protection of indigenous technical knowledge and also the germplasm of the locallandraces/ farmers' varieties.
Realizing the importance of collecting and conserving PGRFA, India has taken strategic steps for their ex situ conservationusing appropriate approaches. Major part of this work has been carried out under Indian Council of Agricultural Research(ICAR) by the National Bureau of Plant Genetic Resources (NBPGR), New Delhi, with its 10 regional stations/base centres/quarantine centres' over different phyto-geographic zones of the country and active collaboration and linkages withover 40 National Active Germplasm Sites (NAGS). The National Genebank of NBPGR has three types of storage facilities -seed genebank, cryogenebank and in vitro genebank. During last ten years emphasis is to collect and conserve local varieties/ landraces, wild/weedy relatives, farmers varietieswith desirable traits, trails specific germplasm and specialized genetic stocks to be taken in priority as preparedness for addressing issues of food and nutritional security, climate change and IPRs

Agricultural ecosystems that harbour diversity of PGRFA are more in a state of flux, as compared to other naturalecosystems, since cropping patterns are changing every season. Modern agricultural practices strongly favour reduction of crop diversity by providing the subsidies for cultivating high yielding varieties and reducing weeds/wild plants diversity by using crop protection measures. By providing positive incentives to local communities, this diversity may be maintained14. Thus there is a great need to assess the state of PGRFA diversity at regular intervals to record changes in species population as well as monitoring genetic erosion, if any. Keeping in view the value of PGRFA, the following thrust areas have been identified:

• Identification of gaps in management of PGRFA;
• Assesment of loss of diversity in farming systems using continued analysis of land use patterns; in crop diversity within a crop species through genetic diversity analysis; and in wild and weedy relatives at in situ level;
• Collection of genetic diversity in crops and their wild relatives;
• Characterization, evaluation, multiplication and conservation of trait specific material;
• Documentation of information on diversity in PGRFA;
• Linkages with organisations involved in management of PGRFA; and
• Awareness generation.

The data provided by stakeholders indicated that regular survey and updation is required to assess status of PGRFA with reference to number of crops cultivated in an area and number of varieties of each crop being cultivated in that area. Similar situation is seen in relation to diversity available. There is a need to further investigate in this area and update information on assessment of diversity distribution of PGRFA and genetic erosion. Despite the fact that a lot of survey and inventorization has been done over the years under various programmes at NBPGR, its Regional Stations and on plant biodiversity there is a need to collect more information from unexplored areas as well as areas explored more than 20 years back. Measurement of genetic erosion and assessment of concentration of diversity should be monitored through ground surveys and modern tools (GIS) for mapping of PGRFA. To better understand the roles and values of the diversity of PGRFA, emphasis should be given on the food and cultural habits of the tribal communities of the country which are highly dependent on local diversity for their survival. For monitoring of genetic erosion and quick response to observed erosion, a combined effort needs to be globally monitored through networking systems.

Aquaculture
Provides livelihood security to more than 14 million people. Fish is one of the cheapest sources of animal protein and availability and affordability is better for fish in comparison to other animal protein. Fish serves as a health food owing to the fish oils which are rich in polyunsaturated fatty acids, vitamins and minerals. Fish culture is considered important to meet the growing future demand for food especially as a health food. Aquaculture has been growing consistently at the rate of 9% per annum since last 2 decades. As per recent estimates, Indian aquaculture is projected to grow by121% by the year 2030. Per capita consumption of the fish in India is 9.7 kg. The total fish production is 10 million metric tons. A wide variety of fishes are bring caught from sea and freshwater for consumption and export. There are lot of efforts are being taken for conserving the biodiversity of fishes such as declaring protected area, declaring closed season, cryopreservation of fish milt and cells. Exploration and cataloguing of fishes, for identifying population, species and sub species level are also being carried out. NBFGR is mandated exclusively to conduct research on various aspects of fish genetic resource management in India.

Microbes

In India, diversity of microorganisms and their conservation especially ex-situ has given emphasis for the utilization of microorganisms in agriculture and allied sectors. More than 10 years ago, Govt. of India has established a bureau for conservation of agriculturally important microorganisms that could be utilized in various agricultural practices. Soil biodiversity plays a role in soil fertility, soil erosion, nutrient uptake by plants, formation of soil organic matter, nitrogen fixation, the biodegradation of dead plant and animal material, reducing hazardous waste, the production of organic acids that weather rocks, and control of plant and insect populations through natural biocontrol. Microbial diversity and its richness to the environment provide a huge reservoir of resources, which we can utilize for our benefit. The microbes have developed an extensive range of metabolic pathways, which has traditionally been exploited by man in processes such as fermentation, production of antibiotics, vitamins, etc. More recently, this largely unexplored reservoir of resources has begun to be harnessed for innovative applications useful to mankind. Many biofertilizer formulation especially of nitrogen fixers, phosphorus, potassium and zinc solubilizers, sulphur oxidizing bacteria, AM fungi have been developed and utilized to fulfil the nutrient needs of the plant. Many formulations based on Trichoderma, Bacillus, Pseudomonas, Beauveria and Metrahizium are developed for control of fungal pathogens and insect pests.Due to climate changes, deterioration of soil quality and depletion of soil nutrients especially micronutrients, new kind of microbes are being used to mitigate abiotic stresses caused by nutrient deficiency, drought, salinity, temperature, etc. Biofortification of micronutrients in crops like wheat and rice has been attributed to different microbes like Piriformaspora indica, bacterial species belonging to Bacillus and Arthrobacter. Natural calamities like flash floods, Tsunami contribute to loss or shift in microbial diversity. The major risk associated with loss of soil biodiversity is because of practice of burning of standing crop residues on soil and frequent occurrence of fire in forest areas. Such practices in long run will completely destroy living nature of soil in India and thus soil become unproductive for ever.

Production systems in the country

IMPORTANT: Throughout these guidelines, questions on production systems will refer to the production systems identified in Table 1 as present in your country.

4. Indicate, for each of the production systems listed in Table 1 below, whether it is found in your country or not, regardless of its importance.

Table 1. Production systems present in the country.

Sector	**Code**	**Production system names** (Place pointer on the production system name for a detailed description)	**Check if present in the country**
Livestock	L1	Livestock grassland-based systems: Tropics	☒
	L2	Livestock grassland-based systems: Subtropics	☒
	L3	Livestock grassland-based systems: Temperate	☒
	L4	Livestock grassland-based systems: Boreal and /or highlands	☒
	L5	Livestock landless systems: Tropics	☒
	L6	Livestock landless systems: Subtropics	☒
	L7	Livestock landless systems: Temperate	☒
	L8	Livestock landless systems: Boreal and /or highlands	☒
Forest	F1	Naturally regenerated forests: Tropics	☒
	F2	Naturally regenerated forests: Subtropics	☒
	F3	Naturally regenerated forests: Temperate	☒
	F4	Naturally regenerated forests: Boreal and /or highlands	☐
	F5	Planted forests: Tropics	☒
	F6	Planted forests: Subtropics	☒
	F7	Planted forests: Temperate	☒
	F8	Planted forests: Boreal and /or highlands	☐
Aquaculture and Fisheries	A1	Self-recruiting capture fisheries: Tropics	☒
	A2	Self-recruiting capture fisheries: Subtropics	☒
	A3	Self-recruiting capture fisheries: Temperate	☒
	A4	Self-recruiting capture fisheries: Boreal and /or highlands	☐
	A5	Culture-based fisheries: Tropics	☒
	A6	Culture-based fisheries: Subtropics	☒
	A7	Culture-based fisheries: Temperate	☐
	A8	Culture-based fisheries: Boreal and /or highlands	☐
	A9	Fed aquaculture: Tropics	☒
	A10	Fed aquaculture: Subtropics	☒
	A11	Fed aquaculture: Temperate	☒
	A12	Fed aquaculture: Boreal and /or highlands	☐
	A13	Non-fed aquaculture: Tropics	☒
	A14	Non-fed aquaculture: Subtropics	☒
	A15	Non-fed aquaculture: Temperate	☐

	A16	Non-fed aquaculture: Boreal and /or highlands	☐
Crops	C1	Irrigated crops (rice) : Tropics	☐
	C2	Irrigated crops (rice) : Subtropics	☐
	C3	Irrigated crops (rice) : Temperate	☐
	C4	Irrigated crops (rice) : Boreal and /or highlands	☐
	C5	Irrigated crops (other) : Tropics	☒
	C6	Irrigated crops (other) : Subtropics	☒
	C7	Irrigated crops (other) : Temperate	☒
	C8	Irrigated crops (other) : Boreal and /or highlands	☒
	C9	Rainfed crops : Tropics	☒
	C10	Rainfed crops : Subtropics	☒
	C11	Rainfed crops : Temperate	☒
	C12	Rainfed crops : Boreal and /or highlands	☒
Mixed	M1	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	☒
	M2	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	☒
	M3	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	☒
	M4	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	☒
Others [please specify]	O1		☒
Others [please specify]	O2		☐
Others [please specify]	O3		☐
Others [please specify]	O4		☐
Others [please specify]	O5		☐

5. Provide in Table 2 a description for each production system. Countries may wish to use the following criteria, where information is available:

Environmental features and characteristics:

a) additional information on climate (arid, semi-arid, humid, subhumid);
b) features of the landscape mosaic.

Rural livelihoods and sustainable use:

c) share of smallholders;
d) proportion of the production system found in urban or peri-urban context;
e) share of the population actively contributing to the production system disaggregated by gender, including number of employees if available;
f) importance of the production system to the incomes, livelihoods and well-being of rural communities;
g) levels of agricultural intensification and the reliance of synthetic inputs, modern varieties, fossil fuels, etc.

Table 2. Description or characterization of production systems within the country

Production system	**Description**

Livestock grassland-based systems: Tropics	• Hot arid ecoregion with red and black soils • Hot semi-arid ecoregion with medium and deep black soils • Hot semi-arid ecoregion with shallow and medium (dominant) black soils • Hot subhumid ecoregion with red and black soils • Hot subhumid ecoregion with red and lateritic soils • Hot subhumid to semi-arid ecoregion with coastal alluvium derived soils • Hot humid perhumid ecoregion with red, lateritic and alluvium derived soils
Livestock grassland-based systems: Subtropics	• Hot semi-arid ecoregion with medium and deep black soils • Hot subhumid ecoregion with red and black soils • Hot subhumid ecoregion with red and yellow soils • Hot subhumid ecoregion with red and lateritic soils • Hot subhumid (moist) ecoregion with alluvium-derived soils • Hot subhumid (moist) to humid (inclusion of perhumid) ecoregion with alluvium-derived soils • Warm perhumid ecoregion with brown and red hill soils • Warm perhumid ecoregion with red and lateritic soils • Hot subhumid to semi-arid ecoregion with coastal alluvium derived soils • Hot humid per humid island ecoregion with red loamy and sandy soils
Livestock grassland-based systems: Temperate	• Warm subhumid to humid with inclusion of perhumid ecoregion with brown forest and podzolic soils
Livestock grassland-based systems: Boreal and /or highlands	• Cold arid eco-region with shallow skeletal soils
Livestock landless systems: Tropics	• Hot arid eco-region with desert and saline soils • Hot arid ecoregion with red and black soils • Hot semi-arid ecoregion with medium and deep black soils • Hot semi-arid ecoregion with shallow and medium (dominant) black soils • Hot semi-arid ecoregion with red loamy soils • Hot subhumid (dry) ecoregion with alluvium-derived soils • Hot subhumid ecoregion with red and black soils • Hot subhumid ecoregion with red and lateritic soils • Hot subhumid to semi-arid ecoregion with coastal alluvium derived soils • Hot humid perhumid ecoregion with red, lateritic and alluvium derived soils
Livestock landless systems: Subtropics	• Hot arid eco-region with desert and saline soils • Hot semi-arid ecoregion with medium and deep black soils • Hot subhumid (dry) ecoregion with alluvium-derived soils • Hot subhumid ecoregion with red and black soils • Hot subhumid ecoregion with red and yellow soils • Hot subhumid ecoregion with red and lateritic soils • Hot subhumid (moist) ecoregion with alluvium-derived soils • Hot subhumid (moist) to humid (inclusion of perhumid) ecoregion with alluvium-derived soils • warm perhumid ecoregion with brown and red hill soils • Warm perhumid ecoregion with red and lateritic soils • Hot subhumid to semi-arid ecoregion with coastal alluvium derived soils
Livestock landless systems: Temperate	• Warm subhumid to humid with inclusion of perhumid ecoregion with brown forest and podzolic soils
Livestock landless systems: Boreal and /or highlands	• Warm subhumid to humid with inclusion of perhumid ecoregion with brown forest and podzolic soils
Naturally regenerated forests: Tropics	• Primary: Forests of native species, where there are no clearly visible indications of human activities and the ecological processes are not directly distributed by humans. • Modified natural: Forests of naturally regenerated native species where there are clearly visible indications of significant human activities. • Semi natural: silvicultural practices in natural forest by intensive management (weeding, fertilizing, thinning, selective logging). • All months with monthly mean temperature, corrected to sea level, above 18º C

Naturally regenerated forests: Subtropics	• Primary: Forests of native species, where there are no clearly visible indications of human activities and the ecological processes are not directly distributed by humans. • Modified natural: Forests of naturally regenerated native species where there are clearly visible indications of significant human activities. • Semi natural: silvicultural practices in natural forest by intensive management (weeding, fertilizing, thinning, selective logging). • One or more months with monthly mean temperatures, corrected to sea level, below 18º C but above 5º C
Naturally regenerated forests: Temperate	• Primary: Forests of native species, where there are no clearly visible indications of human activities and the ecological processes are not directly distributed by humans. • Modified natural: Forests of naturally regenerated native species where there are clearly visible indications of significant human activities. • Semi natural: silvicultural practices in natural forest by intensive management (weeding, fertilizing, thinning, selective logging). • A least one month with monthly mean temperatures, corrected to sea level, below 5º C and four or more months above 10º C
Planted forests: Tropics	• Semi natural (Planted component): Forests of native species, established through planting or seedling, intensively managed. • Plantations (Productive): Forests of introduced and/ or native species established through planting or seeding mainly for production of wood or non wood goods. • Plantations (Protective): Forests of introduced and/ or native species established through planting or seeding mainly for provision of services. • All months with monthly mean temperature, corrected to sea level, above 18º C
Planted forests: Subtropics	• Semi natural (Planted component): Forests of native species, established through planting or seedling, intensively managed. • Plantations (Productive): Forests of introduced and/ or native species established through planting or seeding mainly for production of wood or non wood goods. • Plantations (Protective): Forests of introduced and/ or native species established through planting or seeding mainly for provision of services. • One or more months with monthly mean temperatures, corrected to sea level, below 18º C but above 5º C
Planted forests: Temperate	• Semi natural (Planted component): Forests of native species, established through planting or seedling, intensively managed. • Plantations (Productive): Forests of introduced and/ or native species established through planting or seeding mainly for production of wood or non wood goods. • Plantations (Protective): Forests of introduced and/ or native species established through planting or seeding mainly for provision of services. • A least one month with monthly mean temperatures, corrected to sea level, below 5º C and four or more months above 10º C
Self-recruiting capture fisheries: Tropics	Capture fisheries primarily supported from freshwater reservoirs, wetlands, rivers and lakes; brackishwater lakes, estuaries and marine environment.
Self-recruiting capture fisheries: Subtropics	Capture fisheries primarily supported from freshwater reservoirs, rivers and lakes;
Self-recruiting capture fisheries: Temperate	Capture fisheries contributing marginally from freshwater rivers and streams.
Culture-based fisheries: Tropics	Man made reservoirs and lakes primarily supported by Indian carps.
Culture-based fisheries: Subtropics	Man made reservoirs and lakes primarily supported by Indian carps.
Fed aquaculture: Tropics	Indian and Chinese carps (under polyculture system), pangasius, tilapia, freshwater prawns, shrimps, mudcrabs, lobsters, Asian seabass, cobia, silver pompano and milkfish.
Fed aquaculture: Subtropics	Indian and Chinese carps (under polyculture system), pangasius, tilapia, freshwater prawns.

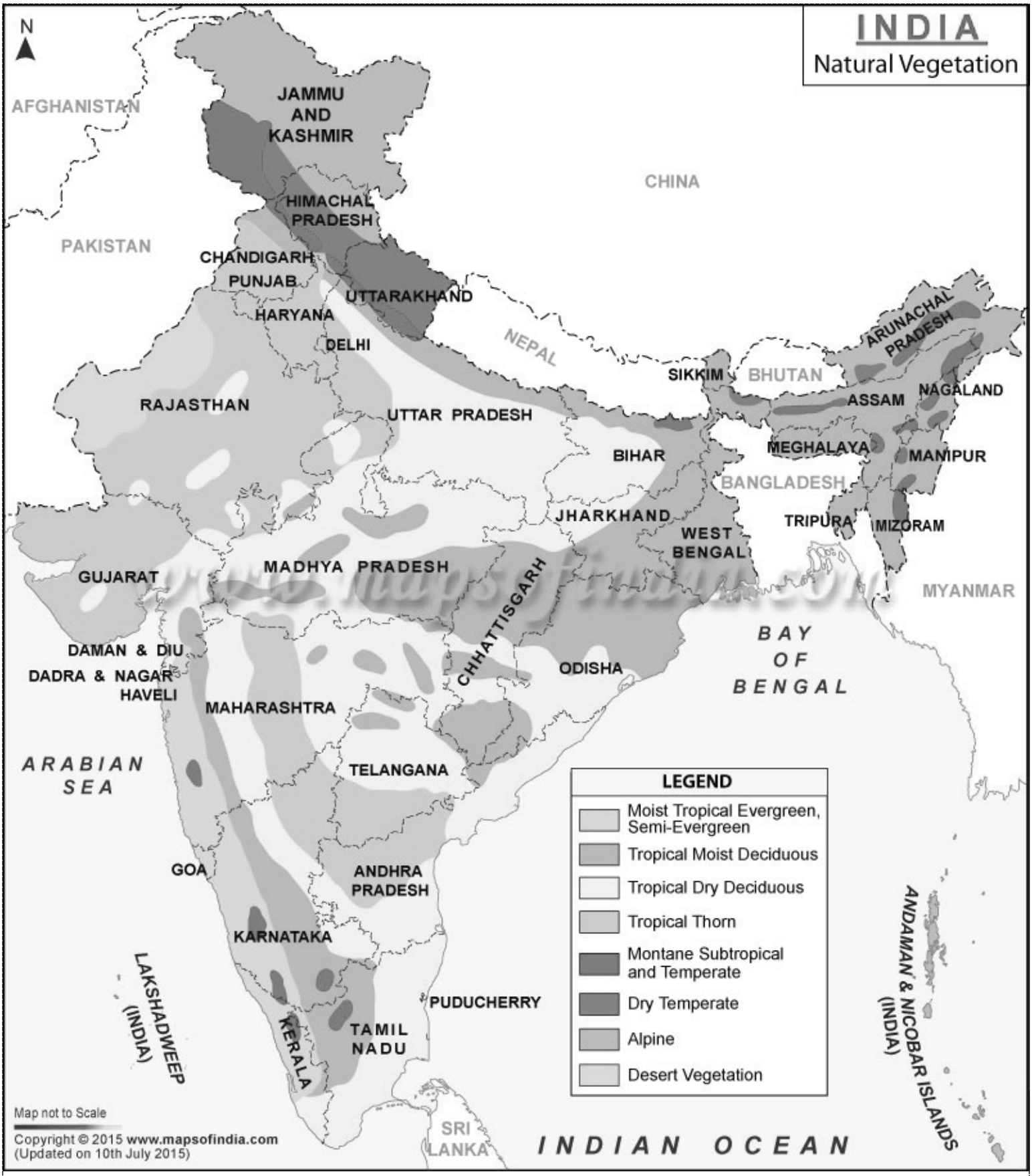
Fed aquaculture: Temperate	Culture of Chinese carps and trout.
Non-fed aquaculture: Tropics	Indian carps and freshwater prawns in small reservoirs and lakes. Mussel farming in brackishwater.
Non-fed aquaculture: Subtropics	Indian carps in small reservoirs and lakes.
Irrigated crops (other) : Tropics	• Rice, sorghum, pearl millet, maize, groundnut and cotton are predominant crops grown in high rainfall areas
Irrigated crops (other) : Subtropics	
Irrigated crops (other) : Temperate	Wheat, Barley, Mustard, Sesame, Peas etc.
Irrigated crops (other) : Boreal and /or highlands	
Rainfed crops : Tropics	• India ranks first among the rainfed agricultural countries of the world in terms of both extent and value of produce. • Rainfed agriculture is practiced in two-thirds of the total cropped area of 162 million hectares(66 per cent). • Rainfed agriculture supports 40 per cent of the national food basket. The importance of rainfed agriculture is obvious from the fact that 55 per cent of rice, 91 per cent coarse grains, 90 per cent pulses, 85 per cent oilseeds and 65 per cent cotton are grown in rainfed areas.
Rainfed crops : Subtropics	
Rainfed crops : Temperate	• Fruit crops, nuts and other small fruits are suitable to grow in this regions
Rainfed crops : Boreal and /or highlands	
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	• Hot arid eco-region with desert and saline soils • Hot arid ecoregion with red and black soils • Hot semi-arid ecoregion with medium and deep black soils • Hot semi-arid ecoregion with shallow and medium (dominant) black soils • Hot semi-arid ecoregion with red loamy soils • Hot subhumid (dry) ecoregion with alluvium-derived soils • Hot subhumid ecoregion with red and black soils • Hot subhumid ecoregion with red and lateritic soils • Hot subhumid to semi-arid ecoregion with coastal alluvium derived soils • Hot humid perhumid ecoregion with red, lateritic and alluvium derived soils
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	• Hot arid eco-region with desert and saline soils • Hot semi-arid ecoregion with medium and deep black soils • Hot subhumid (dry) ecoregion with alluvium-derived soils • Hot subhumid ecoregion with red and black soils • Hot subhumid ecoregion with red and yellow soils • Hot subhumid ecoregion with red and lateritic soils • Hot subhumid (moist) ecoregion with alluvium-derived soils • Hot subhumid (moist) to humid (inclusion of perhumid) ecoregion with alluvium-derived soils • Warm perhumid ecoregion with brown and red hill soils • Warm perhumid ecoregion with red and lateritic soils • Hot subhumid to semi-arid ecoregion with coastal alluvium derived soils • Hot humid per humid island ecoregion with red loamy and sandy soils
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	• Warm subhumid to humid with inclusion of perhumid ecoregion with brown forest and podzolic soils • Integrated farming of Indian carps with livestocks and agriculture. Shrimp culture along with paddy (brackishwater) and murrels in paddy fields.

Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	• Warm subhumid to humid with inclusion of perhumid ecoregion with brown forest and podzolic soils • Integrated farming of Indian carps with livestocks and agriculture.
Others/Industrial production system	• Commercial ventures of Poultry and Dairy have been established. Poultry farms are high in number in Southern and Northern states. Commercial dairy ventures have been established in Northern states.

6. Provide a map of production systems in your country, marking the places and regions mentioned in the Country Report.

Add

Delete



Click to upload map

7. For each production system found in your country (refer to Table 1), indicate in Table 3 the area under production (km^2, hectares, acres, other). If not applicable, indicate the estimated production quantity (major products aggregated) using the appropriate unit or measure (tonne, head, inventory, cubic metre, etc.) for the production system. If available, indicate the contribution of the production system to the agricultural sector economy in the country (%). Please use the most recent data available and indicate the year of reference for the data or estimates. Specify NK if not known or NA if not applicable.

Table 3. Area under production, production quantity and contribution to the agricultural sector economy of production systems in the country.

Production systems	**Area**		**Production - quantity**		**Contribution to the agricultural sector economy**	**Reference year**
	Value	**Unit (enter)**	**Value**	**Unit (enter)**	**%**	**year**
Livestock grassland-based systems: Tropics	NK		Milk-137.69 million tones Meat- 6.24 million tones Eggs-74.75 billion no. Wool-48.14 million kg Source: Basic Animal Husbandry Statistics, Govt. of India (2015)		24.8%	2013-14
Livestock grassland-based systems: Subtropics	NK					
Livestock grassland-based systems: Temperate	NK					
Livestock grassland-based systems: Boreal and /or highlands	NK					
Livestock landless systems: Tropics	NK					
Livestock landless systems: Subtropics	NK					
Livestock landless systems: Temperate	NK					
Livestock landless systems: Boreal and /or highlands	NK					
Naturally regenerated forests: Tropics	65.1	mha.	1.35	m3/ha/yr	1.7% of National GDP	
Naturally regenerated forests: Subtropics	4.2	mha.	7.66	m3/ha/yr		
Naturally regenerated forests: Temperate	7.7	mha.	4.5	m3/ha/yr		
Planted forests: Tropics						
Planted forests: Subtropics						
Planted forests: Temperate						

Self-recruiting capture fisheries: Tropics	2.05	m. sq. km	4.0	mmt	2.3	2015
Self-recruiting capture fisheries: Subtropics	0.3	m. ha	0.05	mmt	-	2015
Self-recruiting capture fisheries: Temperate	0.28	m. ha	0.01	mmt	-	2015
Culture-based fisheries: Tropics	0.25	m. ha	0.08	mmt	-	2015
Culture-based fisheries: Subtropics	-	-	-	-	-	-
Fed aquaculture: Tropics	2.20	m. ha	4.5	mmt		2015
Fed aquaculture: Subtropics	0.06	m. ha	0.5	mmt		2015
Fed aquaculture: Temperate	0.02	m. ha	0.1	mmt		2015
Non-fed aquaculture: Tropics	NK					
Non-fed aquaculture: Subtropics	0.01					
Irrigated crops (other) : Tropics						
Irrigated crops (other) : Subtropics	64.35	m. ha				
Irrigated crops (other) : Temperate						
Irrigated crops (other) : Boreal and /or highlands						
Rainfed crops : Tropics						
Rainfed crops : Subtropics						
Rainfed crops : Temperate	NK					
Rainfed crops : Boreal and /or highlands	NK					
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	0.01	m.ha	0.001	mmt	-	2015
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	NK					
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate						
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands						

8. Comment on the effects on biodiversity for food and agriculture of production destined for exportation versus production for local and/or national consumption. Where information is available, indicate for each production system the proportion of production that is destined for export, the major commodities involved, the impact on the methods of production (e.g. adoption of specific production practices to meet export needs) and the implications for biodiversity.

Agriculture
Major commodities identified for export are Tea, Coffee, basmati rice, wheat, Pulses, Tobacco, Spices, Cashew, Sesame, Niger, other cereals, Sugar, fresh vegetables, castor oil, oil meals etc. The biodiversity available in these crops are been shared with other countries with export mode for food and agriculture. Being adapted in different climatic regions of world these crops may exhibit diverse gene pool of genetic resources in the concern crop. As a result heritability of the quantitative characters may be observed which will be benefit for advancement in the genetic makeup of the crop for future utilization.

Livestock
Livestock products produced in India are consumed locally or within the country. However, during 2013-14, Value of export of livestock and livestock products was Rs. 589.11 billion, which is 3.1% of total export of India. This include Rs. 272.13 billion from meat and edible meat offal, Rs. 185.97 billion from animal fodder and feed, Rs. 78.03 billion from raw hide and skins & leathers, Rs. 42.74 billion from Dairy and poultry products & honey, Rs. 9.55 billion from raw wool and animal hair and Rs. 0.69 billion from livestock. On the other hand, value of import of livestock and livestock products during 2013-14 was Rs 78.13 billion (0.29% of total import of India), which include Rs. 0.62 billion from livestock, Rs. 0.12 billion from meat and edible meat offal, Rs. 2.26 billion from dairy and poultry products & honey, Rs. 17.39 billion from animal fodder and feed, Rs. 34.97 billion from raw hide and skins & leather, Rs. 22.78 billion from raw wool and animal hair.

Aquaculture
Total fish production in the country is 10 million metric tons which includes, marine capture fisheries, inland capture fisheries, and aquaculture. Capture fisheries from marine and inland contribute 4.0 million metric tons and aquaculture contribute 6.0 million metric tons. India export fishes more than 1.0 mt, worth US $ 5.5 b, which includes total 60 items. Major exporting items are frozen shrimps, frozen molluscs, and frozen fish. The most exported species are white leg shrimp, Litopnenaeus vannamei, tiger shrimp, Penaeus monodon and Indian white shrimp, Fenneropenaeus indicus. All the sea food processing factories have implemented HACCP in their process line to meet international standards. Marine products development authority (MPEDA) has made mandatory for sea food exports from India to include catch data certificate of the fish.

CHAPTER 2: Drivers of change

Proposed structure of the chapter and information to be included in the Country Reports

This Chapter provides an assessment of the major drivers causing changes (drivers list and descriptions provided in Annex 3), either positive or negative, on the state of biodiversity for food and agriculture in the country, with specific attention to changes in the associated biodiversity in and around production systems, ecosystem services and wild foods. This Chapter also encourages countries to compare drivers between different production systems.

The Chapter will address the following topics related to drivers of change in biodiversity for food and agriculture:

- The effects of drivers and stressors over the past ten years on a) associated biodiversity, b) ecosystem services and c) wild foods;
- Impacts of drivers on the involvement of women in the maintenance and use of biodiversity for food and agriculture, the application and preservation of traditional knowledge, and rural poverty alleviation;
- Countermeasures addressing current and emerging drivers, best practices and lessons learned.

The Country Report should include information or reference to any specific studies that have been carried out in the last ten or so years that relate observed changes in the extent or distribution of associated biodiversity and wild foods in the country to different drivers.

IMPORTANT: Throughout these guidelines, questions on production systems will refer to the production systems identified in Table 1 as present in your country.

One of the main objectives of this report is to identify knowledge gaps and to provide baseline information for future assessments. Thus please indicate where information is unavailable.

Effects of drivers of change on associated biodiversity

9. What have been the most important drivers affecting the extent and distribution of associated biodiversity in the last 10 years in your country? In describing the drivers you may wish to indicate the production systems where associated biodiversity is most affected and identify drivers that are common to the various components of associated biodiversity listed. Indicate where possible the indicators used to measure changes, along with the sources of information.

Agriculture

Agriculture faces the unprecedented challenge of securing food supplies for a rapidly growing human population, while seeking to minimize adverse impacts on the environment. Recent reports indicate that crop growth and yield are adversely affected by abiotic and biotic factors including weather (rain, heat and temperature), soil conditions (water, pH and nutrients), insect populations, disease incidence and management practices (cultivar, irrigation, fertilization and rotation). These factors represent the principal cause of crop failure, decreasing average yields for major crops. Salinity is one of the most devastating environmental stresses, which causes major reductions in cultivated land area, crop productivity and quality. It has been estimated that an approximate area of 7 million hectares of land is covered by saline soil in India (Patel et al. 2011). Most of this occurs in indogangetic plains that covers the states of Punjab, Haryana, Uttar Pradesh, Bihar and some parts of Rajasthan. Arid tracts of Gujarat and Rajasthan and semi-arid tracts of Gujarat, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh are also largely affected by saline lands. It is also predicted that the salinized areas are increasing at a rate of 10% annually due to low precipitation, high surface evaporation, weathering of native rocks, irrigation with saline water, and poor cultural practices etc. (Shrivastava and Kumar 2014). As a result, soil salinity imposes ion toxicity, osmotic stress, nutrient (N, Ca, K, P, Fe, Zn) deficiency and oxidative stress on plants, and thus limits water uptake from soil. Under such a situation, plant-associated microorganisms can play an important role in conferring resistance to abiotic stresses. It is also interesting to note that the microbes isolated from different stressed habitats possess stress tolerance capacity along with the plant growth-promoting traits and are potential candidates for seed priming. Based on this concept, Tiwari et al. (2011) reported enhanced root and shoot length, biomass, and biochemical levels such as chlorophyll, carotenoids, and protein in wheat plants in saline soils. Upadhyay et al. (2011) studied the impact of PGPR inoculation on growth and antioxidant status of wheat under saline conditions and reported that co-inoculation with Bacillus subtilis and Arthrobacter sp. could alleviate the adverse effects of soil salinity on wheat growth with an increase in dry biomass, total soluble sugars and proline content. Likewise, Jha et al. (2011) reported that P. pseudoalcaligenes, an endophytic bacterium in combination with a rhizospheric B. pumilus in paddy was able to protect the plant from abiotic stress by induction of osmoprotectant and antioxidant proteins more efficiently than by the rhizospheric or endophytic bacteria alone at early stages of growth. Plants inoculated with endophytic bacterium P. pseudoalcaligenes showed a significantly higher concentration of glycine betaine-like quaternary compounds and higher shoot biomass at lower salinity levels. While at higher salinity levels, a mixture of both P. pseudoalcaligenes and B. pumilus showed better response against the adverse effects of salinity. Besides this, the complex and dynamic interactions among microorganisms, roots, soil and water in the rhizosphere induce changes in physicochemical and structural properties of the soil. Microbial polysaccharides can bind soil particles to form micro- and macro-aggregates. Plant roots and fungal hyphae fit in the pores between microaggregates and thus stabilize macroaggregates. Plants treated with Exo-polysaccharides (EPS) producing bacteria display increased resistance to water and salinity stress due to improved soil structure (Sandhya et al., 2009). EPS can also bind to cations including Na+ thus making it unavailable to plants under saline conditions. More recently, Ramadoss et al. (2013) studied the effect of five plant growth promoting halotolerant bacteria on wheat growth and found that inoculation of those halotolerant bacterial strains to ameliorate salt stress in wheat seedlings resulted in increased root length. In particular, Hallobacillus sp. and B. halodenitrificans showed more than 90% increase in root elongation and 17.4% increase in dry weight when compared to uninoculated wheat seedlings at 320 mM NaCl stress indicating a significant reduction of the deleterious effects of NaCl. All these reports indicate that halotolerant bacteria isolated from saline environments have potential to enhance plant growth under saline stress through direct or indirect mechanisms and would be most appropriate as bioinoculants under such conditions. The isolation of indigenous microorganisms from the stress affected soils and screening on the basis of their stress tolerance and PGP traits may be useful in the rapid selection of efficient strains that could be used as bioinoculants for stressed crops.

Aquaculture

Population growth and demand for fish products, change in government policy, environmental changes in riverine system, introduction of exotic species, emergence of new aquaculture technologies, disease, establishment of protected areas.

10. Where associated biodiversity is believed to be affected by climate change, please provide additional information on the nature, severity and frequency of the climate threat and the production systems impacted.

Agriculture
Changes in biodiversity are driven by combinations of drivers that work over time, on different scales, and that tend to amplify each other. For example, population and income growth combined with technological advances can lead to climate change. They have affected species distributions, population sizes, and the timing of reproduction or migration events, as well as the frequency of pest and disease outbreaks. Projected changes in climate by 2050 could lead to the extinction of many species living in certain limited geographical regions. The Intergovernmental Panel on Climate Change (IPCC) project that the average surface temperature will rise by 2 to 6.4C by 2100 compared to pre-industrial levels. This is expected to cause global negative impacts on biodiversity. Exposure to one threat often makes a species more susceptible to a second, and so on, multiple threats may have unexpectedly dramatic impacts on biodiversity.

The climatic conditions affecting biodiversity is frequent drought and flood situation in the country. Another important event occurring is earthquakes that may severely damaging biodiversity and ecosystem functions.

Aquaculture
Total decline in the marine catch (5.3%) due to climate change, ElNino effects and over exploitation. The main groups declined are sardine (51%), mackerel and small pelagics.

Microbes
Climate change impacts on agriculture are being witnessed all over the world. Increased incidences of abiotic and biotic stresses caused by climate change are impacting productivity in principal crops. Extreme events like prolonged droughts, intense rains and flooding, heat waves and frost damages are likely to further increase in future due to climate change. Up to two third of the cropped area in India is affected by some form or other stresses like drought, salinity, alkalinity, low pH and metal toxicity. Successful utilization of agriculturally important microorganisms in crop production, crop protection and environmental management in these areas warrants a thorough understanding of the factors governing their natural distribution, selection of stress tolerant strains, development of effective inoculant formulations/delivery methods that ensure their survival under stress and adoption of management practices that favour the survival of the organisms introduced in soils
The outstanding stress factor in India is drought or soil moisture deficit, which affects nearly two third area forming part of the arid and semi-arid ecosystems. The other important abiotic stresses are high temperature, soil salinity/alkalinity, low pH and metal toxicity. Soil erosion due to water and wind leads to removal of fertile top soil thus reducing effective soil volume. In extreme cases, it leads to ravines and finally the wastelands. The event coupled with imbalanced nutrient availability causes both water and nutrient stress in major parts of the country. Nearly 11 million ha area is affected by salinity, the chemical stress and another 16 million ha by water logging, a physical stress. Soil acidity and alkalinity are other factors affecting significant area in the country. Of late, most of the peri-urban areas are affected by heavy metal pollution although its magnitude has not been fully documented. All these stress factors have a significant bearing on performance of AIMS.

Effects of drivers of change on biodiversity for food and agriculture

This section applies to all biodiversity for food and agriculture. Countries that previously presented or are currently preparing a Country Report on Forest, Aquatic, Animal or Plant Genetic Resources, may wish to use these reports as reference.

11. For each production system present in your country as indicated in Table 1, fill in the code and name of each production system in Table 4 (repeat Table for each production system). For each production system indicate which drivers have been influencing biodiversity for food and agriculture, disaggregated by sector, during the past 10 years (description of drivers can be found in Annex 3). Drivers may have a strongly positive (2), positive (1), negative (-1), and strongly negative effect (-2), or no effect at all (0) on biodiversity for food and agriculture. If the effect of the driver is unknown or not applicable, please indicate not known (NK) or not applicable (NA).

Table 4. Effect of drivers on sector biodiversity within production systems in the country, by animal (AnGR), plant (PGR), aquatic (AqGR) and forest (FGR) genetic resources.

Production systems	**Drivers**	**Effect of drivers on sector biodiversity for food and agriculture** (2, 1, 0,-1, -2, NK, NA)			
	(Place pointer on the driver name for a detailed description)	PGR	FGR	AnGR	AqGR

Livestock grassland-based systems: Tropics	Changes in land and water use and management			0	
	Pollution and external inputs			0	
	Over-exploitation and overharvesting			-1	
	Climate change			-1	
	Natural disasters			0	
	Pests, diseases, alien invasive species			+1	
	Markets, trade and the private sector			NK	
	Policies			0	
	Population growth and urbanization			0	
	Changing economic, socio-political, and cultural factors			0	
	Advancements and innovations in science and technology			+1	
	Other [*please specify*]:				
Livestock grassland-based systems: Subtropics	Changes in land and water use and management			-1	
	Pollution and external inputs			-1	
	Over-exploitation and overharvesting			-1	
	Climate change			-1	
	Natural disasters			0	
	Pests, diseases, alien invasive species			0	
	Markets, trade and the private sector			+1	
	Policies			0	
	Population growth and urbanization			-1	
	Changing economic, socio-political, and cultural factors			0	
	Advancements and innovations in science and technology			+2	
	Other [*please specify*]:				
Livestock grassland-based systems: Temperate	Changes in land and water use and management			-1	
	Pollution and external inputs			0	
	Over-exploitation and overharvesting			-1	
	Climate change			-1	
	Natural disasters			-1	
	Pests, diseases, alien invasive species			0	
	Markets, trade and the private sector			0	
	Policies			0	

	Population growth and urbanization			-1	
	Changing economic, socio-political, and cultural factors			0	
	Advancements and innovations in science and technology			+1	
	Other [*please specify*]:				
Livestock grassland-based systems: Boreal and /or highlands	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				
	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				
	Other [*please specify*]:				
Livestock landless systems: Tropics	Changes in land and water use and management			-1	
	Pollution and external inputs			-1	
	Over-exploitation and overharvesting			-1	
	Climate change			0	
	Natural disasters			0	
	Pests, diseases, alien invasive species			0	
	Markets, trade and the private sector			+1	
	Policies			0	
	Population growth and urbanization			-1	
	Changing economic, socio-political, and cultural factors			0	
	Advancements and innovations in science and technology			0	
	Other [*please specify*]:				
Livestock landless systems: Subtropics	Changes in land and water use and management			-1	
	Pollution and external inputs			-1	
	Over-exploitation and overharvesting			-1	

	Climate change			0	
	Natural disasters			-1	
	Pests, diseases, alien invasive species			0	
	Markets, trade and the private sector			0	
	Policies			0	
	Population growth and urbanization			-1	
	Changing economic, socio-political, and cultural factors			-1	
	Advancements and innovations in science and technology			0	
	Other [*please specify*]:				
Livestock landless systems: Temperate	Changes in land and water use and management			0	
	Pollution and external inputs			0	
	Over-exploitation and overharvesting			-1	
	Climate change			-1	
	Natural disasters			0	
	Pests, diseases, alien invasive species			0	
	Markets, trade and the private sector			0	
	Policies			0	
	Population growth and urbanization			-1	
	Changing economic, socio-political, and cultural factors			-1	
	Advancements and innovations in science and technology			0	
	Other [*please specify*]:				
Livestock landless systems: Boreal and /or highlands	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				
	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				

	Other [*please specify*]:				
Naturally regenerated forests: Tropics	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				
	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				
	Other [*please specify*]:				
Naturally regenerated forests: Subtropics	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-2			
	Climate change	-1			
	Natural disasters	-2			
	Pests, diseases, alien invasive species	-1			
	Markets, trade and the private sector	0			
	Policies	0			
	Population growth and urbanization	+1			
	Changing economic, socio-political, and cultural factors	+1			
	Advancements and innovations in science and technology	0			
	Other [*please specify*]:	0			
Naturally regenerated forests: Temperate	Changes in land and water use and management	0			
	Pollution and external inputs	0			
	Over-exploitation and overharvesting	-1			
	Climate change	-2			
	Natural disasters	-2			
	Pests, diseases, alien invasive species	-1			
	Markets, trade and the private sector	0			

	Policies	0			
	Population growth and urbanization	0			
	Changing economic, socio-political, and cultural factors	+1			
	Advancements and innovations in science and technology	0			
	Other [*please specify*]:	0			
Planted forests: Tropics	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				
	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				
	Other [*please specify*]:				
Planted forests: Subtropics	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				
	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				
	Other [*please specify*]:				
Planted forests: Temperate	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				

	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				
	Other [*please specify*]:				
Self-recruiting capture fisheries: Tropics	Changes in land and water use and management				-2
	Pollution and external inputs				-1
	Over-exploitation and overharvesting				-2
	Climate change				-2
	Natural disasters				-1
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				1
	Policies				1
	Population growth and urbanization				-1
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				2
	Other [*please specify*]:				NA
Self-recruiting capture fisheries: Subtropics	Changes in land and water use and management				-2
	Pollution and external inputs				-1
	Over-exploitation and overharvesting				-2
	Climate change				-1
	Natural disasters				-1
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				1
	Policies				1
	Population growth and urbanization				-1
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				2

	Other [*please specify*]:				NA
Self-recruiting capture fisheries: Temperate	Changes in land and water use and management				NK
	Pollution and external inputs				-2
	Over-exploitation and overharvesting				NK
	Climate change				-1
	Natural disasters				-1
	Pests, diseases, alien invasive species				NK
	Markets, trade and the private sector				0
	Policies				NK
	Population growth and urbanization				NK
	Changing economic, socio-political, and cultural factors				NK
	Advancements and innovations in science and technology				1
	Other [*please specify*]:				NA
Culture-based fisheries: Tropics	Changes in land and water use and management				-1
	Pollution and external inputs				-1
	Over-exploitation and overharvesting				NA
	Climate change				0
	Natural disasters				0
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				2
	Policies				2
	Population growth and urbanization				2
	Changing economic, socio-political, and cultural factors				1
	Advancements and innovations in science and technology				2
	Other [*please specify*]:				NA
Culture-based fisheries: Subtropics	Changes in land and water use and management				-1
	Pollution and external inputs				-1
	Over-exploitation and overharvesting				NA
	Climate change				0
	Natural disasters				-1
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				1

	Policies				0
	Population growth and urbanization				1
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				1
	Other [*please specify*]:				NA
Fed aquaculture: Tropics	Changes in land and water use and management				-2
	Pollution and external inputs				-2
	Over-exploitation and overharvesting				NA
	Climate change				0
	Natural disasters				-1
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				2
	Policies				2
	Population growth and urbanization				1
	Changing economic, socio-political, and cultural factors				NA
	Advancements and innovations in science and technology				2
	Other [*please specify*]:				NA
Fed aquaculture: Subtropics	Changes in land and water use and management				-1
	Pollution and external inputs				-1
	Over-exploitation and overharvesting				NA
	Climate change				NA
	Natural disasters				-1
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				1
	Policies				1
	Population growth and urbanization				1
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				1
	Other [*please specify*]:				NA
Fed aquaculture: Temperate	Changes in land and water use and management				-1
	Pollution and external inputs				NA
	Over-exploitation and overharvesting				-1

	Climate change				-1
	Natural disasters				-1
	Pests, diseases, alien invasive species				0
	Markets, trade and the private sector				0
	Policies				0
	Population growth and urbanization				0
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				1
	Other [*please specify*]:				NA
Non-fed aquaculture: Tropics	Changes in land and water use and management				-1
	Pollution and external inputs				-1
	Over-exploitation and overharvesting				NA
	Climate change				-1
	Natural disasters				-1
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				1
	Policies				1
	Population growth and urbanization				1
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				1
	Other [*please specify*]:				NA
Non-fed aquaculture: Subtropics	Changes in land and water use and management				-1
	Pollution and external inputs				-1
	Over-exploitation and overharvesting				NA
	Climate change				-1
	Natural disasters				-1
	Pests, diseases, alien invasive species				-1
	Markets, trade and the private sector				0
	Policies				0
	Population growth and urbanization				0
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				0

	Other [*please specify*]:				NA
Irrigated crops (other) : Tropics	Changes in land and water use and management	-1			NK
	Pollution and external inputs	-1			NK
	Over-exploitation and overharvesting	-1			NK
	Climate change	-1			NK
	Natural disasters	-1			NK
	Pests, diseases, alien invasive species	0			NK
	Markets, trade and the private sector	1			NK
	Policies	1			0
	Population growth and urbanization	1			0
	Changing economic, socio-political, and cultural factors	1			0
	Advancements and innovations in science and technology	1			1
	Other [*please specify*]:				NA
Irrigated crops (other) : Subtropics	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-1			
	Climate change	-1			
	Natural disasters	-1			
	Pests, diseases, alien invasive species	0			
	Markets, trade and the private sector	1			
	Policies	1			
	Population growth and urbanization	1			
	Changing economic, socio-political, and cultural factors	1			
	Advancements and innovations in science and technology	1			
	Other [*please specify*]:				
Irrigated crops (other) : Temperate	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-1			
	Climate change	-1			
	Natural disasters	-1			
	Pests, diseases, alien invasive species	0			
	Markets, trade and the private sector	1			

	Policies	1			
	Population growth and urbanization	1			
	Changing economic, socio-political, and cultural factors	1			
	Advancements and innovations in science and technology	1			
	Other [*please specify*]:				
Irrigated crops (other) : Boreal and /or highlands	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-1			
	Climate change	-1			
	Natural disasters	-1			
	Pests, diseases, alien invasive species	0			
	Markets, trade and the private sector	1			
	Policies	1			
	Population growth and urbanization	1			
	Changing economic, socio-political, and cultural factors	1			
	Advancements and innovations in science and technology	1			
	Other [*please specify*]:				
Rainfed crops : Tropics	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-1			
	Climate change	-1			
	Natural disasters	-1			
	Pests, diseases, alien invasive species	0			
	Markets, trade and the private sector	1			
	Policies	1			
	Population growth and urbanization	1			
	Changing economic, socio-political, and cultural factors	1			
	Advancements and innovations in science and technology	1			
	Other [*please specify*]:				
Rainfed crops : Subtropics	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-1			

	Climate change	-1			
	Natural disasters	-1			
	Pests, diseases, alien invasive species	0			
	Markets, trade and the private sector	1			
	Policies	1			
	Population growth and urbanization	1			
	Changing economic, socio-political, and cultural factors	1			
	Advancements and innovations in science and technology	1			
	Other [*please specify*]:				
Rainfed crops : Temperate	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-1			
	Climate change	-1			
	Natural disasters	-1			
	Pests, diseases, alien invasive species	0			
	Markets, trade and the private sector	1			
	Policies	1			
	Population growth and urbanization	1			
	Changing economic, socio-political, and cultural factors	1			
	Advancements and innovations in science and technology	1			
	Other [*please specify*]:				
Rainfed crops : Boreal and /or highlands	Changes in land and water use and management	-1			
	Pollution and external inputs	-1			
	Over-exploitation and overharvesting	-1			
	Climate change	-1			
	Natural disasters	-1			
	Pests, diseases, alien invasive species	0			
	Markets, trade and the private sector	1			
	Policies	1			
	Population growth and urbanization	1			
	Changing economic, socio-political, and cultural factors	1			
	Advancements and innovations in science and technology	1			

	Other [*please specify*]:				
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	Changes in land and water use and management	-1		0	
	Pollution and external inputs	-1		-1	
	Over-exploitation and overharvesting	-1		-1	
	Climate change	-1		0	
	Natural disasters	-1		-1	
	Pests, diseases, alien invasive species	0		-1	
	Markets, trade and the private sector	1		+1	
	Policies	1		+1	
	Population growth and urbanization	1		-1	
	Changing economic, socio-political, and cultural factors	1		-1	
	Advancements and innovations in science and technology	1		+1	
	Other [*please specify*]:				
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	Changes in land and water use and management				NK
	Pollution and external inputs				NK
	Over-exploitation and overharvesting				NA
	Climate change				NK
	Natural disasters				NK
	Pests, diseases, alien invasive species				NK
	Markets, trade and the private sector				0
	Policies				0
	Population growth and urbanization				0
	Changing economic, socio-political, and cultural factors				0
	Advancements and innovations in science and technology				0
	Other [*please specify*]:				NA
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	Changes in land and water use and management	-1		-1	
	Pollution and external inputs	-1		-1	
	Over-exploitation and overharvesting	-1		-1	
	Climate change	-1		-1	
	Natural disasters	-1		-1	
	Pests, diseases, alien invasive species	0		-1	

	Markets, trade and the private sector	1		0	
	Policies	1		+1	
	Population growth and urbanization	1		-1	
	Changing economic, socio-political, and cultural factors	1		-1	
	Advancements and innovations in science and technology	1		+1	
	Other [*please specify*]:				
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				
	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				
	Other [*please specify*]:				
	Changes in land and water use and management				
	Pollution and external inputs				
	Over-exploitation and overharvesting				
	Climate change				
	Natural disasters				
	Pests, diseases, alien invasive species				
	Markets, trade and the private sector				
	Policies				
	Population growth and urbanization				
	Changing economic, socio-political, and cultural factors				
	Advancements and innovations in science and technology				
	Other [*please specify*]:				

Effects of drivers of change on associated biodiversity

12. What have been the main drivers affecting regulating and supporting ecosystem services in the country during the last 10 years? Describe, for each production system, the major driver(s) affecting ecosystem services and indicate the effect on ecosystem services as being strongly positive (2), positive (1), negative (-), strongly negative (-2), no effect (0), not known (NK), or not applicable (NA) in Table 5 (repeat table for each production system). Place pointer on the ecosystem service name for a detailed description.

Table 5. Major drivers and their effect on ecosystem services in production systems.

Production systems	**Drivers**	**Effect of drivers on ecosystem services** (2, 1, 0,-1, -2, NK, NA) (Place pointer on the ecosystem service name for a detailed description)								
	(Place pointer on the driver name for a detailed description)	Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Habitat provisioning	Production of oxygen/ Gas regulation
Livestock grassland-based systems: Tropics	Changes in land and water use and management		-1							
	Pollution and external inputs		-1							
	Over-exploitation and overharvesting		-1							
	Climate change		-1							
	Natural disasters		-1							
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		0							
	Policies		+1							
	Population growth and urbanization		-1							
	Changing economic, socio-political, and cultural factors		0							
	Advancements and innovations in science and technology		+1							
	Other [*please specify*]:									
Livestock grassland-based systems: Subtropics	Changes in land and water use and management		-1							
	Pollution and external inputs		-1							
	Over-exploitation and overharvesting		-1							
	Climate change		-1							
	Natural disasters		0							

	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		0							
	Policies		+1							
	Population growth and urbanization		-1							
	Changing economic, socio-political, and cultural factors		0							
	Advancements and innovations in science and technology		+1							
	Other [*please specify*]:									
Livestock grassland-based systems: Temperate	Changes in land and water use and management		-1							
	Pollution and external inputs		-1							
	Over-exploitation and overharvesting		-1							
	Climate change		-1							
	Natural disasters		0							
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		0							
	Policies		+1							
	Population growth and urbanization		-1							
	Changing economic, socio-political, and cultural factors		0							
	Advancements and innovations in science and technology		+1							
	Other [*please specify*]:									
Livestock grassland-based systems: Boreal and /or highlands	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									

Livestock landless systems: Tropics	Changes in land and water use and management		-1							
	Pollution and external inputs		-1							
	Over-exploitation and overharvesting		-1							
	Climate change		-1							
	Natural disasters		0							
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		0							
	Policies		+1							
	Population growth and urbanization		-1							
	Changing economic, socio-political, and cultural factors		0							
	Advancements and innovations in science and technology		+1							
	Other [*please specify*]:									
Livestock landless systems: Subtropics	Changes in land and water use and management		-1							
	Pollution and external inputs		-1							
	Over-exploitation and overharvesting		-1							
	Climate change		-1							
	Natural disasters		0							
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		0							
	Policies		+1							
	Population growth and urbanization		-1							
	Changing economic, socio-political, and cultural factors		0							
	Advancements and innovations in science and technology		+1							
	Other [*please specify*]:									
Livestock landless systems: Temperate	Changes in land and water use and management		-1							
	Pollution and external inputs		-1							
	Over-exploitation and overharvesting		-1							
	Climate change		-1							
	Natural disasters		0							
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		0							
	Policies		+1							

	Population growth and urbanization		-1							
	Changing economic, socio-political, and cultural factors		0							
	Advancements and innovations in science and technology		+1							
	Other [*please specify*]:									
Livestock landless systems: Boreal and /or highlands	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Naturally regenerated forests: Tropics	Changes in land and water use and management	0	0	-1	-1	-1	0	-1	NK	-1
	Pollution and external inputs	0	NK	-1	-2	-1	-1	-1	NK	-2
	Over-exploitation and overharvesting	0	NK	-2	-1	0	0	-1	NK	-1
	Climate change	-1	-1	0	0	0	-1	-1	NK	-2
	Natural disasters	-1	-1	0	0	0	-1	0	NK	-1
	Pests, diseases, alien invasive species	-1	-1	0	0	0	0	-1	NK	-1
	Markets, trade and the private sector	0	NK	0	0	0	0	0	NK	0
	Policies	0	NK	0	0	0	0	0	NK	0
	Population growth and urbanization	0	NK	-1	0	0	0	0	NK	0
	Changing economic, socio-political, and cultural factors	0	0	-1	0	0	0	0	NK	0
	Advancements and innovations in science and technology	0	0	-1	0	0	0	0	NK	0
	Other [*please specify*]:	0	0	0	0	0	0	0	NK	0
Naturally regenerated forests: Subtropics	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									

	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Naturally regenerated forests: Temperate	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Planted forests: Tropics	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									

	Other [*please specify*]:									
Planted forests: Subtropics	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Planted forests: Temperate	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Self-recruiting capture fisheries: Tropics	Changes in land and water use and management		-1	-1		-1				
	Pollution and external inputs		-1	-1		-1				
	Over-exploitation and overharvesting			-1				-1		
	Climate change		-1	-1						
	Natural disasters		-1	-1		-1	-1		-1	
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1		-1		-1		

	Policies		1	1		1		1		
	Population growth and urbanization		-1	-1				-1		
	Changing economic, socio-political, and cultural factors		-1	-1						
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Self-recruiting capture fisheries: Subtropics	Changes in land and water use and management		-1	-1				-1		
	Pollution and external inputs		-1	-1		-1				
	Over-exploitation and overharvesting		-1	-1						
	Climate change		-1	-1						
	Natural disasters			-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1		-1				
	Policies		1	1		1		1		
	Population growth and urbanization		-1	-1				-1		
	Changing economic, socio-political, and cultural factors		-1	-1						
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Self-recruiting capture fisheries: Temperate	Changes in land and water use and management		-1	-1				-1		
	Pollution and external inputs		-1	-1				-1		
	Over-exploitation and overharvesting		-1	-1						
	Climate change		-1	-1						
	Natural disasters		-1	-1		-1		-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1				-1		
	Policies		1	1		1		1		
	Population growth and urbanization		-1	-1				-1		
	Changing economic, socio-political, and cultural factors		-1	-1				-1		
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Culture-based fisheries: Tropics	Changes in land and water use and management		-1	-1				-1		
	Pollution and external inputs		-1	-1		-1		-1		
	Over-exploitation and overharvesting		-1	-1						

	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1						
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1				-1		
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Culture-based fisheries: Subtropics	Changes in land and water use and management		-1	-1				-1		
	Pollution and external inputs		-1	-1						
	Over-exploitation and overharvesting		-1	-1				-1		
	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1				-1		
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1				-1		
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Fed aquaculture: Tropics	Changes in land and water use and management		-1	-1		-1		-1		
	Pollution and external inputs		-1	-1		-1		-1		
	Over-exploitation and overharvesting		-1	-1		-1		-1		
	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1				-1		
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1		-1		-1		
	Advancements and innovations in science and technology		2	2		1		1		

	Other [*please specify*]:									
Fed aquaculture: Subtropics	Changes in land and water use and management		-1	-1		-1		-1		
	Pollution and external inputs		-1	-1		-1		-1		
	Over-exploitation and overharvesting		-1	-1				-1		
	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1				-1		
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1		-1		-1		
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Fed aquaculture: Temperate	Changes in land and water use and management		-1	-1		-1		-1		
	Pollution and external inputs		-1	-1				-1		
	Over-exploitation and overharvesting		-1	-1		-1		-1		
	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1				-1		
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1						
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Non-fed aquaculture: Tropics	Changes in land and water use and management		-1	-1						
	Pollution and external inputs		-1	-1						
	Over-exploitation and overharvesting			-1						
	Climate change			-1				-1		
	Natural disasters			-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1						

	Policies		2	2				1		
	Population growth and urbanization		-1	-1				-1		
	Changing economic, socio-political, and cultural factors		-1	-1				-1		
	Advancements and innovations in science and technology		2	2				1		
	Other [*please specify*]:									
Non-fed aquaculture: Subtropics	Changes in land and water use and management			-1						
	Pollution and external inputs		-1	-1						
	Over-exploitation and overharvesting			-1				-1		
	Climate change			-1				-1		
	Natural disasters			-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1				-1		
	Policies		2	2				1		
	Population growth and urbanization		-1	-1				-1		
	Changing economic, socio-political, and cultural factors		-1	-1				-1		
	Advancements and innovations in science and technology		2	2				-1		
	Other [*please specify*]:									
Irrigated crops (other) : Tropics	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Irrigated crops (other) : Subtropics	Changes in land and water use and management	-1	0	0	-1	-1	-1	-2	-2	-2
	Pollution and external inputs	-1	0	-1	-1	-1	-1	-2	-2	-2
	Over-exploitation and overharvesting	-2	0	-1	-1	-1	-1	-1	-2	-2

	Climate change	-2	-1	-1	-1	-1	-1	-2	-2	0
	Natural disasters	-2	-1	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	NK	0	0	0	0	0	0	0	0
	Markets, trade and the private sector	NK	NK	-1	-1	-1	-1	-1	-1	-1
	Policies	0	0	-1	-1	-1	-1	-1	-1	-1
	Population growth and urbanization	-2	0	1	1	1	1	-1	-1	-1
	Changing economic, socio-political, and cultural factors	-2	0	1	1	1	1	-1	-1	-1
	Advancements and innovations in science and technology	1	1	1	1	1	1	1	1	1
	Other [*please specify*]:									
Irrigated crops (other) : Temperate	Changes in land and water use and management	-1	0	0	-1	-1	-1	-2	-2	-2
	Pollution and external inputs	-1	0	-1	-1	-1	-1	-2	-2	-2
	Over-exploitation and overharvesting	-2	0	-1	-1	-1	-1	-1	-2	-2
	Climate change	-2	-1	-1	-1	-1	-2	-2	-2	0
	Natural disasters	-2	-1	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	NK	0	0	0	0	0	0	0	0
	Markets, trade and the private sector	NK	NK	-1	-1	-1	-1	-1	-1	-1
	Policies	0	0	-1	-1	-1	-1	-1	-1	-1
	Population growth and urbanization	-2	0	-1	-1	-1	-1	-1	-1	-1
	Changing economic, socio-political, and cultural factors	-2	0	1	1	1	1	-1	-1	-1
	Advancements and innovations in science and technology	1	1	1	1	1	1	1	1	1
	Other [*please specify*]:									
Irrigated crops (other) : Boreal and /or highlands	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									

	Other [*please specify*]:									
Rainfed crops : Tropics	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Rainfed crops : Subtropics	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Rainfed crops : Temperate	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									

	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Rainfed crops : Boreal and /or highlands	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	Changes in land and water use and management		-1	-1		-1		-1		
	Pollution and external inputs		-1	-1		-1		-1		
	Over-exploitation and overharvesting		-1	-1		-1		-1		
	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1		-1		-1		
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1		-1		-1		
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	Changes in land and water use and management		-1	-1		-1		-1		

	Pollution and external inputs		-1	-1		-1		-1		
	Over-exploitation and overharvesting		-1	-1		-1		-1		
	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		-1	-1				-1		
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1		-1		-1		
	Advancements and innovations in science and technology		2	2		1		1		
	Other [*please specify*]:									
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	Changes in land and water use and management		-1	-1		-1		-1		
	Pollution and external inputs		-1	-1		-1		-1		
	Over-exploitation and overharvesting		-1	-1		-1		-1		
	Climate change		-1	-1				-1		
	Natural disasters		-1	-1				-1		
	Pests, diseases, alien invasive species		-1							
	Markets, trade and the private sector		0	-1		-1		-1		
	Policies		2	2		1		1		
	Population growth and urbanization		-1	-1		-1		-1		
	Changing economic, socio-political, and cultural factors		-1	-1		-1		-1		
	Advancements and innovations in science and technology		-1							
	Other [*please specify*]:									
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									

	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									
	Changes in land and water use and management									
	Pollution and external inputs									
	Over-exploitation and overharvesting									
	Climate change									
	Natural disasters									
	Pests, diseases, alien invasive species									
	Markets, trade and the private sector									
	Policies									
	Population growth and urbanization									
	Changing economic, socio-political, and cultural factors									
	Advancements and innovations in science and technology									
	Other [*please specify*]:									

13. Briefly describe the main driver(s) affecting ecosystem services in each production system, as identified in Table 5. Include where possible a description of the components of associated biodiversity that are affected, the indicators used to measure change, and the source of information.

Pest and diseases affect ecosystems strongly as they reduce crop production highly significantly, particularly due to climate change as some group of pests are known to attain higher level of occurrence. Effect on change in ecosystem due to various abiotic factors and chemical interference that alters pollinators' diversity; some of them are very crucial for crop production and produce from useful insects.

Fisheries contributes 5.4% of agricultural GDP and market trade and private sectors plays an important role in fish production. Overexploitation and over harvesting causes pollution which leads to disease in fishes. Natural disasters and climate change negatively affects the ecosystem services such as water cycling and nutrient cycling. Pollution and external inputs also negatively affects water purification, nutrient and water cycling.

Effects of drivers of change on wild foods

14. What were the main drivers affecting the availability, knowledge and diversity of wild foods during the last ten years in the country? In Table 6, indicate the major drivers affecting availability, knowledge and diversity of wild foods, and if the effects are strongly positive (2), positive (1), negative (-1), strongly negative (-2), no effect (0), not known (NK), or not applicable (NA).

Table 6. Drivers affecting availability, knowledge and diversity of wild foods.

Drivers	**Effect of drivers** (2, 1, 0,-1, -2, NK, NA)

Drivers	Effect of drivers (2, 1, 0,-1, -2, NK, NA)		
(Place pointer on the driver name for a detailed description)	Availability of wild foods	Knowledge of wild foods	Diversity of wild food
Changes in land and water use and management	-1	1	-1
Pollution and external inputs	-1	1	-1
Over-exploitation and overharvesting	-1	1	-1
Climate change	-1	1	-1
Natural disasters	-1	1	-1
Pests, diseases, alien invasive species	-1	1	-1
Markets, trade and the private sector	-1	1	1
Policies	1	1	1
Population growth and urbanization	1	1	-1
Changing economic, socio-political, and cultural factors	1	1	-1
Advancements and innovations in science and technology	1	1	1
Other [*please specify*]:			

15. Briefly describe the main drivers affecting the availability, diversity and knowledge of wild foods in your country, as identified in Table 6. Include where possible indicators used to measure change, along with the source of information.

Policies, markets trade and private sector, changing economic, socio-political, and cultural factors
The pest and diseases diversity is depleting or attaining status fast due to deforestation, urbanization, climate change and unsystematic exploitation of resources. This situation demands an urgent need to collect, document and conserve the diversity through various means including molecular by next generation sequencing method. Most pest and diseases occur almost in all ecosystems like tropical and sub-tropical, while specific pest and diseases occur in temperate region. They occur seasonally all over the India in various habitats such as humus rich soils, decaying plant litter and wood logs in forests as well as in meadows and even in sandy and other soils. India, being one of the top 10 mega diverse nations of the world, has ample species of pest and diseases. The diversity of geographical, ecological and climatic conditions prevailing in India has made this country a natural habitat for a large number of species. Six regions, viz., Eastern Himalayan, northwest Himalayan, Indo Gangetic Plain, Western Ghats, southern India and Rajasthan have been explored by a number of workers throughout the country as hot spots of diversity.

The macrofungal (mushroom) diversity is depleting fast due to deforestation, urbanization, climate change and unsystematic exploitation through collection of wild mushrooms. This situation demands an urgent need to collect, document and conserve this group. Most macrofungi are cosmopolitan, occurring both in tropical and temperate regions. They occur seasonally all over the world in various habitats such as humus rich soils, decaying plant litter and wood logs in forests as well as in meadows and even in sandy and other soils. Some species, particularly mycorrhizal mushrooms are on the verge of extinction. India, being one of the top 10 mega diverse nations of the world, has ample species of wild mushrooms which occur mainly during the rainy season. The diversity of geographical, ecological and climatic conditions prevailing in India has made this country a natural habitat for a large number of fungal species. Six regions, viz., Eastern Himalayan, northwest Himalayan, Indo Gangetic Plain, Western Ghats, southern India and Rajasthan have been explored by a number of workers throughout the country as hot spots of mushroom diversity.

Fisheries production mainly comes from self-recruitment capture fisheries-Tropics and Fed aquaculture-Tropics. Wild collections are mainly coming from exclusive economic zone of Bay of Bengal, Arabian Sea, Andaman and Nicobar Islands and Indian Ocean, lakes and reservoirs. Climate change is the one of the most important factor for the reduction of fishes from the sea. During 2015, India's total fish production fell by 5.3% due to climate change and El-Nino effect. Overexploitation and over harvesting coupled with population growth and urbanization impacts negatively on availability of wild fishes. Pollution, pest diseases and alien species also major factor for reduction of wild fishes from the nature.

Effects of drivers of change on traditional knowledge, gender and rural livelihoods

In answering questions 16 to 18, describe the major drivers that have had an impact in the last 10 years and include where possible indicators used to measure change, and sources of information.

16. Which drivers have had the most significant effect on the involvement of women in the maintenance and use of biodiversity for food and agriculture?

Changing economic, socio-political and cultural factors; Markets, traders and the private sector

17. Which drivers have had the most significant effect on the maintenance and use of traditional knowledge relating to biodiversity for food and agriculture?

Changes in land and water use and management, climate change, natural dissasters

1. Pests, diseases, alien invasive species
2. Population growth and urbanization
3. Changing economic, socio-political, and cultural factors

18. Which drivers have had the most significant effect on the role of biodiversity for food and agriculture in improving food security and sustainability?

Advancements and innovations in science and technology, changes in land and water use and management

1. Changing economic, socio-political, and cultural factors
2. Policies

Countermeasures addressing current and emerging drivers of change, best practices and lessons learned

19. Referring to the information provided in this Chapter, identify countermeasures planned or in place to reduce adverse consequences of drivers on a) associated biodiversity, b) ecosystem services and c) wild foods. Provide any expected outcomes, lessons learned and best practices.

The loss of grazing land, population growth and urbanization with over exploitation of resources leads to loss in farm animal diversity and its associated biodiversity. The countermeasures planned to protect biodiversity among domestic animals includes few programmes developed by the government of India. However, the effect of policy and programmes and efforts made so far, seems to be inadequate to counter the loss of biodiversity in domestic farm animal and their sustainable utilization. The domestic animals of India and their products and by-products from domestic animals are not covered under the category of wild foods therefore; the drivers affecting wild foods could not be ascertained.

Protected areas declared in marine and freshwater ecosystems, ex situ and in situ conservation programmes, good aquaculture practices and certification protocols, quarantine measures in imports, regulation of germplasm transfer and exchange are implemented.

CHAPTER 3: The state and trends of biodiversity for food and agriculture

Proposed structure of the chapter and information to be included in the Country Reports

The main objective of this Chapter is to describe the state of biodiversity for food and agriculture in the country, with an emphasis on associated biodiversity and wild foods, and to identify current trends. The Chapter should also indicate current gaps and future needs and priorities. Where possible, countries should identify interventions required to support maintenance of associated biodiversity and indicate whether action is required at local, national, regional or global levels.

This Chapter will seek information on the following topics:

- The state of diversity between and (where any information exists) within species with respect to associated biodiversity and wild foods;
- The importance of the different components of associated biodiversity in relation to ecosystem services;
- The main factors influencing the state of genetic diversity with an emphasis on threatened and endangered species and resources;
- The state of activities and of the development of monitoring and information systems on the state of biodiversity for food and agriculture;
- The state of any specific conservation actions that target associated biodiversity and wild foods;
- Major gaps in the information available and opportunities and priorities for improving knowledge of state and trends of biodiversity for food and agriculture.

Where possible, indicate whether the information systems are gender-sensitive, specifying to what extent the different types and levels of knowledge of women and men are taken into account.

I*MPORTANT: Throughout these guidelines, questions on production systems will refer to the production systems identified in Table 1 as present in your country.*

One of the main objectives of this report is to identify knowledge gaps and to provide baseline information for future assessments. Thus please indicate where information is unavailable.

Overall synthesized assessment of forest, aquatic, animal or plant genetic resources

Countries that previously presented or are currently preparing a Country Report on Forest, Aquatic, Animal or Plant Genetic Resources may have important information on genetic diversity in these various reports. Therefore, Countries may wish to take full advantage of their different sector reports to develop a comprehensive description and comparison of the state, trends, and state of conservation of forest, aquatic, animal or plant genetic resources. The following indications are designed to provide guidance on the topics that could be addressed.

20. Describe the overall 1) state, 2) trends and 3) state of conservation of diversity of forest, aquatic, animal or plant genetic resources in your country with respect to:

a) common characteristics shared by all sectors;
b) major differences between sectors;
c) synergies or trade-offs in the state of diversity between sectors.

The responses should include relevant information on socio-economic, political and cultural dimensions as well as biological ones. Information on the significance of common characteristics, differences, synergies and trade-offs with respect to achieving food security and nutrition, sustainable production or the provision of ecosystem services should also be provided.

Livestock India possesses 13 non-carnivore mammalian and avian species domesticated so far, that include cattle, buffalo, sheep, goat, pig, horse, donkey, camel, yak, mithun, rabbit, chicken and duck. Most of the species are having ancient roots of domestication and distributed in almost all parts of the country. Although the distribution of the species is not even, and some of the species are increasing in number with higher pace and some time with the expense of others. During last few years, there is high growth

rate in population of crossbred cattle and buffaloes, which putting a great competition to the indigenous cattle. A large number of indigenous breeds of livestock and poultry have been evolved over a period of thousands of years through natural selection and human intervention, are well adapted to their respective habitat. These breeds evolved with different utility related to food and agricultural, and some time with historical and cultural background. Till 2016, National Bureau of Animal Genetic Resources, Karnal has registered 40 breeds of cattle, 13 breeds of buffalo, 26 breeds of goat, 42 breeds of sheep, 6 breeds of horses and ponies, 9 breeds of camel, 17 chicken breeds, 6 pig breeds and one donkey breed in the country. During last ten years, 31 breeds of different farm animal species has been registered from different parts of the country, particularly in remote areas. Although, this trend seems increasing in coming years. A number of synthetic breeds, strains particularly for cattle, pig, sheep and poultry have been developed with wider adoption by the people for livelihood and nutritional security. The contribution of the animal genetic resources is increasing continuously, Its contribution in total agriculture sector increased from 23 percent to 28 percent during last 10 years. Milk-137.69 million tones, Meat- 6.24 million tones, Eggs-74.75 billion no., Wool-48.14 million kg The contribution of livestock sector to achieve food security and nutrition is also increasing over the year. Milk production of 111MT in year 2005 has been reached to 146 MT in year of 2015, with a growth of around 4 percent annually. Milk availability has also been increased, however, with slightly small growth rate because of increasing population in country. Higher growth for meat and egg has been observed during recent time, specially last ten years. At the same time product like wool from sheep is facing tremendous pressure due to availability of good quality wool from outside countries. With a large number of diversity in form of breeds, country is also facing challenges to conserve some of the indigenous breeds. Serious threat has been observed in indigenous cattle genetic resources, particularly those which are not good milk yielder. More presence of certain exotic cattle breeds-HF, Jersey and their crossbreds, has laid down the foundation of dependency on certain type of breeds only. Likewise, about 22 states have adopted Murrah for crossbreeding of their native buffalo stock. Possibly trend seems worsen in coming years for few of the breeds evolved for drafting. Various conservation programmes are being run by the government-central as well as states to save these breeds. The development and conservation of AnGR has overlapping domains involving the departments of Agricultural Research and Education (DARE) and Animal Husbandry and Dairying (DAHD) in the Ministry of Agriculture, Ministry of Social Justice and Empowerment and Ministry of Environment and Forests. The Department of Biotechnology in the Ministry of Science and Technology also has considerable involvement in conservation through bio-technological tools. These departments undertake activities pertaining to AnGR, although perceptions of conservation and dimensions of activities differ. The Department of Agricultural Research and Education (DARE) is primarily related with research and education on conservation, improvement and development of AnGR whereas the Department of Animal Husbandry and Dairying (DAHD) is related with policy formulation and its execution in these and other aspects of animal husbandry in the country. The Department of Biotechnology lays more emphasis on biotechnological aspects involving development of new technology related with semen, ova, DNA and cell lines etc. to increase the production and productivities of various livestock species. The Ministry of Environment and Forest looks into the aspect related with relationship between the animals and the forests and protection of forests to avoid degradation of environment. The Government has been and continues to be the sole financier for conservation programmes for AnGR in the country. DAHDF and ICAR are putting special efforts in this direction through various network programmes.

Major genetic resources in the fisheries sector are still depend on the wild populations. Hence, generation of knowledge on wild genetic stocks of fish species of cultivable and conservation value is a major priority for the sector. This is in contrast to the scenario in domesticated animals and plants where breeds/varieties etc. are well documented. Hence, bridging this knowledge disparity between fisheries and other agriculture sectors is necessary for formulating common guidelines on issues related to biodiversity, IPR protection and technological advancements. Several initiatives have been undertaken toward this goal. A National Board for Management of Agrobiodiversity has been formed by the Govt. of India to coordinate and guide policies, guidelines and programmes for synergies in management of agro-biodiversity in various sectors related to food and agriculture. Two national level integrated programmes have been undertaken with a clear purpose of studying and utlising agro-biodiversity in major food sectors for sustainable livelihood enhancement and conservation:

1. Harmonising biodiversity conservation and agricultural intensification through integration of plants, animal and fish genetic resources for livelihood security in fragile ecosystems.
2. ICAR-CRP on Agro-biodiversity: National Network on Agro-biodiversity Management.
3. ICAR Outreach Project on Fish Genetic Stocks.

State and trends of associated biodiversity and ecosystem services

This section seeks information on the state of associated biodiversity in different production systems and in relation to the provision of ecosystem regulating and supporting services.

21. Have any changes been detected in your country for the different production systems over the last 10 years in components of associated biodiversity? If so, indicate if trends are strongly increasing (2), increasing (1), stable (0), decreasing (-1) or strongly decreasing (-2) in Table 7. If no information is available, indicate not known (NK). If not applicable, (NA).

Table 7. Trends in the state of components of associated biodiversity within production systems.

Production systems	**Trends in last 10 years (2,1,0,-1,-2, NK, NA)** (Place pointer on the component of associated diversity name for a description)			
	Micro-organisms	Invertebrates	Vertebrates	Plants
Livestock grassland-based systems: Tropics	0	0	0	
Livestock grassland-based systems: Subtropics	0	0	0	
Livestock grassland-based systems: Temperate	0	0	0	
Livestock grassland-based systems: Boreal and /or highlands	0	0	0	
Livestock landless systems: Tropics	0	0	0	
Livestock landless systems: Subtropics	0	0	0	
Livestock landless systems: Temperate	0	0	0	
Livestock landless systems: Boreal and /or highlands	0	0	0	
Naturally regenerated forests: Tropics				
Naturally regenerated forests: Subtropics				
Naturally regenerated forests: Temperate				
Planted forests: Tropics				
Planted forests: Subtropics				
Planted forests: Temperate				
Self-recruiting capture fisheries: Tropics	NK	NK	-1	NA
Self-recruiting capture fisheries: Subtropics	NK	NK	-1	NA
Self-recruiting capture fisheries: Temperate	NK	NK	NK	NA
Culture-based fisheries: Tropics	NK	NK	0	NA
Culture-based fisheries: Subtropics	NK	NK	0	NA
Fed aquaculture: Tropics	-1	-1	0	NA
Fed aquaculture: Subtropics	-1	-1	0	NA
Fed aquaculture: Temperate	NK	NK	NK	NK
Non-fed aquaculture: Tropics	NK	-1	0	NA
Non-fed aquaculture: Subtropics	-1	-1	0	NA

Irrigated crops (other) : Tropics	1	-1	0	0
Irrigated crops (other) : Subtropics	1	-1	0	0
Irrigated crops (other) : Temperate	1	-1	0	0
Irrigated crops (other) : Boreal and /or highlands	NK	NK	NK	NK
Rainfed crops : Tropics	1	-1	0	0
Rainfed crops : Subtropics	1	-1	0	0
Rainfed crops : Temperate	1	-1	0	0
Rainfed crops : Boreal and /or highlands	NK	NK	NK	NK
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	0	0	0	
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	0	0	0	
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	0	0	0	
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	0	0	0	
Industrial Production system	0	0	0	

22. Briefly describe the changes or trends in diversity recorded in Table 7. Where possible provide information on: baseline levels (last 10 years, indicate if otherwise), measurements and indicators used, the extent of change, and the likely cause(s). Include references to the sources of information.

Crops
The assessment of associated diversity related to crop plants indicates no significant difference with relation to vertebrates and associated plants. Some negative impacts indicated in tropics and subtropics, irrigated crops with reference to new strains of pests and pathogens. In the rainfed crops also similar trends are indicated

Livestock
Associated diversity related to microbes/microflora of the rumen and similar organs in livestock does not shown any significant change during last 10 years. However, some of the diseases originated by pathogenic microbes (bacteria, virus) have shown some specific trends. Bird flu in poultry has emerged as new havoc with some time reoccurrence in different parts of country during last ten years. Similarly, neither of any significant change has been observed in invertebrate pest like ticks, lice, fleas, leach etc in recent time. Only a significant change has been observed in the population of vultures in vertebrates useful for biological disposal of carcass. The population of vultures declined drastically possibly due to indiscriminate use of diclofenac salt in the livestock.

Several natural enemies like braconids, ichneumonids, tachinids, etc., which were associated with lepidoptrean insects like Helicoverpa, Earias, Pectinophora are no longer recorded because of cultivation of transgenic cotton, which has drastically reduced these insect population, therefore, has almost reduced their diversity. Also on the crops on which Helicoverpa breeds in others seasons like rabi and summer seasons.

Self-recruiting capture fisheries - tropics is stagnant, production from reservoirs is increasing. Production through fed and non-fed aquaculture is increasing.

23. Have any changes been detected in your country for the different production systems over the last 10 years in regulating and supporting ecosystem services? If so, indicate if trends are strongly increasing (2), increasing (1), stable (0), decreasing (-1) or strongly decreasing (-2) in Table 8. If no information is available, indicate not known (NK). If not applicable, (NA).

Table 8. Trends in the state of regulating and supporting ecosystem services within production systems.

Production systems	**Trends in last 10 years (2,1,0,-1,-2, NK, NA)** (Place pointer on the ecosystem service name for a description)								
	Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Habitat provisioning	Production of oxygen/ Gas regulation
Livestock grassland-based systems: Tropics		1							
Livestock grassland-based systems: Subtropics		1							
Livestock grassland-based systems: Temperate		1							
Livestock grassland-based systems: Boreal and /or highlands		1							
Livestock landless systems: Tropics		1							
Livestock landless systems: Subtropics		1							
Livestock landless systems: Temperate		1							
Livestock landless systems: Boreal and /or highlands		1							
Naturally regenerated forests: Tropics									
Naturally regenerated forests: Subtropics									
Naturally regenerated forests: Temperate									
Planted forests: Tropics									
Planted forests: Subtropics									
Planted forests: Temperate									
Self-recruiting capture fisheries: Tropics			NK		NK				
Self-recruiting capture fisheries: Subtropics			NK		NK				
Self-recruiting capture fisheries: Temperate									
Culture-based fisheries: Tropics			NK		NK				
Culture-based fisheries: Subtropics			NK		NK				
Fed aquaculture: Tropics		-1	-1		NK				
Fed aquaculture: Subtropics			NK		NK				

Fed aquaculture: Temperate			NK		NK				
Non-fed aquaculture: Tropics			NK		NK				
Non-fed aquaculture: Subtropics									
Irrigated crops (other) : Tropics									
Irrigated crops (other) : Subtropics									
Irrigated crops (other) : Temperate									
Irrigated crops (other) : Boreal and /or highlands									
Rainfed crops : Tropics									
Rainfed crops : Subtropics									
Rainfed crops : Temperate									
Rainfed crops : Boreal and /or highlands									
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics		1	NK		NK				
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics		1	NK		NK				
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate		1							
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands		1							

24. Briefly describe the changes or trends in diversity recorded in Table 8. Where possible provide information on: baseline levels (last 10 years, indicate if otherwise), measurements and indicators used, the extent of change, and the likely cause(s). Include references to the sources of information.

Livestock
Some of the diseases originated by pathogenic microbes (bacteria, virus) have shown some specific trends. Bird flu in poultry has emerged as new havoc with some time reoccurrence in different parts of country during last ten years. Similarly, neither of any significant change has been observed in invertebrate pest like ticks, lice, fleas, leach etc in recent time. Trends of incidence of livestock and poultry diseases in India during last 10 years indicated a mixed picture. The incidence of diseases was recorded in terms of no. of outbreaks, no. of animals suffered and no. of death. Significant reduction in no. of outbreaks and no. of death was recorded for the diseases like foot and mouth disease, Hemorrhagic septicemia, Black Quarter, Enterotoxaemia, sheep and goat pox, blue tongue and Peste des petites ruminants(PPR). On the other hand, outbreaks and no. of death from Fowl cholera, Duck Plague, Chronic Respiratory disease, Rabies, Bovine Anaplasmosis and Avian Coryza were increased during last 10 years. The most important epidemics occurred by Avian influenza which resulted into culling of Lakhs of birds (culling of 369484 birds during 2014 only).
Provisioning of habitat: Majority of livestock in India are kept under crop-livestock production system. The main source of livestock feeding is through grazing in permanent pasture and other grazing land. It is important to mention that permanent pasture and other grazing lands are shrinking though at a slow rate. This may affect the diversity of animal genetic resources. The animals kept under industrial production system especially commercial poultry; crossbred cattle and pig is stall fed. These animals require dry fodder, green fodder and concentrate. It is important to note that area under fodder crop has reduced during last 10 years.

There is knowledge gap in aquaculture

25. Is there evidence that changes in biodiversity for food and agriculture have impacted ecosystem services in your country? Indicate if strongly increasing (2), increasing (1), stable (0), decreasing (-1) or strongly decreasing (-2) in Table 9 and provide a description of specific situations and documentation where available.

Table 9. Impact of changes in biodiversity for food and agriculture on ecosystem services.

Production systems	**Changes**	**Impact of changes in biodiversity for food and agriculture on ecosystem services** (2, 1, 0,-1, -2, NK, NA) (Place pointer on the ecosystem service name for a description)								
		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Habitat provisioning	Production of oxygen/ Gas regulation
Livestock grassland-based systems: Tropics	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources		1							
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							
Livestock grassland-based systems: Subtropics	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources		1							
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							

Livestock grassland-based systems: Temperate	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources		1							
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							
Livestock grassland-based systems: Boreal and /or highlands	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Livestock landless systems: Tropics	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources		1							
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							
Livestock landless systems: Subtropics	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources		1							

	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							
Livestock landless systems: Temperate	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources		1							
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							
Livestock landless systems: Boreal and /or highlands	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Naturally regenerated forests: Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									

Naturally regenerated forests: Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Naturally regenerated forests: Temperate	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Planted forests: Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Planted forests: Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									

	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Planted forests: Temperate	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Self-recruiting capture fisheries: Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Self-recruiting capture fisheries: Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Self-recruiting capture fisheries: Temperate	Changes in animal genetic resources									

	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Culture-based fisheries: Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Culture-based fisheries: Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Fed aquaculture: Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									

	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Fed aquaculture: Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Fed aquaculture: Temperate	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Non-fed aquaculture: Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Non-fed aquaculture: Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									

	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Irrigated crops (other) : Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Irrigated crops (other) : Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Irrigated crops (other) : Temperate	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									

	Changes in plants genetic resources (associated biodiversity)									
Irrigated crops (other) : Boreal and /or highlands	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Rainfed crops : Tropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Rainfed crops : Subtropics	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Rainfed crops : Temperate	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK

	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Rainfed crops : Boreal and /or highlands	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							

	Changes in plants genetic resources (associated biodiversity)		1							
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	Changes in animal genetic resources		1							
	Changes in crop genetic resources		1							
	Changes in forest genetic resources		1							
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)		1							
	Changes in invertebrates genetic resources (associated biodiversity)		1							
	Changes in vertebrates genetic resources (associated biodiversity)		1							
	Changes in plants genetic resources (associated biodiversity)		1							
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources	NA	NA	NK	NK	NK	NK	NK	NK	NK
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									
	Changes in animal genetic resources									
	Changes in crop genetic resources									
	Changes in forest genetic resources									
	Changes in aquatic genetic resources									
	Changes in micro-organism genetic resources (associated biodiversity)									
	Changes in invertebrates genetic resources (associated biodiversity)									
	Changes in vertebrates genetic resources (associated biodiversity)									
	Changes in plants genetic resources (associated biodiversity)									

26. Briefly describe the impacts on ecosystem services recorded in Table 9. Where possible provide information on: baseline levels (last 10 years, indicate if otherwise), measurements and indicators used, the extent of change, and the likely cause(s).

Include references to the sources of information.

Livestock

Emergence of crossbred population particularly for cattle, pig, sheep and poultry has impacted the ecosystem services related to pest and disease regulations. Occurrence of certain diseases like FMD, IBR, mastitis in cattle, foot rot in sheep, swine fever and hog cholera in pig and bird flu in poultry has got special attention during recent time.

Incidence of Livestock and poultry Diseases in India 2005 and 2014

SN Disease 2005 2014

Incidence of Livestock and poultry Diseases in India 2005 and 2014

SN	Disease	2005		2014	
		No. of Out breaks	No. of death	No. of Out breaks	No. of death
1.	Foot and Mouth Disease	2270	2797	238	1822
2.	Hemorrhagic Septicemia	775	2229	131	541
3.	Black Quarter	519	956	118	297
4.	Anthrax	119	569	55	2180
5.	Fascioliasis	67	96	192	52
6	Enterotoxaemia	521	3158	50	308
7.	Sheep and Goat Pox	529	64086	88	503
8.	Blue tongue	1183	64086	14	145
9.	Contagious Caprine Pleuro-pneumonia	12	305	2	5
10.	Amphistomiasis	-	-	154	26
11.	Schistosomiasis	-	-	56	0
12.	Swine fever	54	2539	69	289
13.	Salmonellosis	-	-	60	1614
14.	Coccidiosis	313	4199	422	8976
15.	Ranikhet Disease	391	13125	311	18943
16.	Fowl pox	79	313	214	1264
17.	Fowl Cholera	1	2	67	2853
18.	Marek's disease	0	0	48	4767
19.	Infectious Bursal disease	249	11402	183	22127
20	Duck plague	17	168	45	184
21.	Chronic Respiratory Disease	119	7980	459	35885
22.	Canine distemper	-	-	71	88
23.	Rabies	33	84	243	8086
24.	Bovine Babesiosis	26	10	172	8
25.	Mastitis	-	-	354	5
26.	Trypanosomiasis	22	26	105	22
27.	Mange	3	0	45	0
28.	Peste des petites ruminants	1071	15864	82	2419
29.	Bovine Anaplasmosis	13	1	82	7
30.	Bovine Brucellosis	3	0	5	0
31.	Coryza	17	300	46	2612
32.	Avian Influenza (domestic)*	-	-	5	18576
33.	Avian Influenza (wild)	-	-	1	2

*369484 birds culled, Source: Basic Animal Husbandry Statistics, Govt. of India (2015)

Provisioning of habitat: Majority of livestock in India are kept under crop-livestock production system. The main source of livestock feeding is through grazing in permanent pasture and other grazing land. It is important to mention that permanent pasture and other grazing lands are shrinking though at a slow rate. This may affect the diversity of animal genetic resources. The animals kept under industrial production system especially commercial poultry; crossbred cattle and pig is stall fed. These animals require dry fodder, green fodder and concentrate. It is important to note that area under fodder crop has reduced during last 10 years.

Area under fodder crops and permanent pastures and other grazing land in India

Year	Area under fodder crops ('000 ha)	Permanent pastures and other grazing land ('000 ha)
2004-05	8027	10456

2005-06	8066	10444
2007-08	8144	10362
2008-09	8448	10344
2009-10	7390	10340
2010-11	7702	10301
2011-12	7736	10296

There is knowledge gap in aquaculture

27. List any associated biodiversity species or sub-species (if information is available) that are in some way actively managed in your country to help provide regulating or supporting ecosystem services in Table 10. Indicate in which production systems they occur and indicate if diversity information is available. Provide any available sources of information.

Table 10. Associated biodiversity species that are in some way actively managed in your country to help provide regulating or supporting ecosystem services.

Ecosystem service provided (Place pointer on the ecosystem service name for a detailed description)	**Actively managed species (name) and sub-species (where available)**	**Production systems (code or name)**	**Availability of diversity information (Y/N)**	**Source of information**
Pollination				
Pest and disease regulation	Trichoderma harzianum Trichoderma asperllum Chrysoperla species Cryptolaemus montrouzieri Anthocorids Telenomus remus Goniozus nephantidis Acerphagus papayae Trichoderma species Bacillus thuringiensis Bacillus subtilis Pseudomonas fluorescens Beauveria bassiana Metarhizium anisopliae Entomopathogenic nematodes Rhizobium sp. Arthrobacter chroococcum Azospirillum brasilense Penaeus vannamei	Fed aquaculture-Tropics	N	MPEDA
Water purification and waste treatment	Indian carps, Tilapia	Non-fed aquaculture-Tropics	Y	CIFA, CIFRI
Natural hazard regulation				
Nutrient cycling	Dung beetles (Scarabaeidae:Coprinae) Termites (Isoptera) Indian carps, Tilapia	Non-fed aquaculture-Tropics; Mixed ms (Livestock, crop, forest and /or Aquatic and Fisheries: Tropics	Y	CIFA, CIFRI
Soil formation and protection				
Water cycling				
Habitat provisioning				
Production of oxygen/ Gas regulation				

Ecosystem service provided (Place pointer on the ecosystem service name for a detailed description)	**Actively managed species (name) and sub-species (where available)**	**Production systems (code or name)**	**Availability of diversity information (Y/N)**	**Source of information**
Other [*please specify*]:				

28. Does your country have monitoring activities related to associated biodiversity? If yes, describe these. Where possible provide information on the components of associated biodiversity that are monitored and on the geographical coverage of the monitoring system (local, regional, national, global). Include references to the sources of information, if possible.

Yes, for pest and disease biodiversity by taking up regular exploratory surveys in biodiversity hot spots like Andaman, North-eastern regions, sub-Himalayan regions, desert ecosystems and Western Ghat area and in cropped ecosystem to quantify biodiversity.

Indian government has various acts, rules and regulations for helping Indian society to conserve fish and aquatic diversity and judiciously utilise it for the well being of the nation. Govt. of India has enacted a legislation called Biological Diversity Act (BDA) ,2002 and Biological Diversity Rules, 2004. National Biodiversity Authority (NBA) is monitoring activities related to access and use of biodiversity in the country. Under NBA State Biodiversity Boards have been established in 28 states and 31574 Biological Management Committees at the grassroots level across India to implement the provisions of BDA, 2002.

Livestock
There are certain agencies which monitor the associated biodiversity related to microbes, parasites, pests in livestock. Country has large setup in form of departments, institutions, laboratories for controlling the disease causing microbes as well the internal and external parasite invertebrates. DAHDF is nodal agency to vigil as well as taking controlling measures against the disease occurrence, epidemics caused by microbes in livestock. Institutions like IVRI, CCVT, NIVEDI, HISDAL, Directorate on FMD under ICAR are nodal for putting research to control the disease epidemics of bacterial, viral origin. Most of the programmes are run in networking mode involving different agencies of the country. To deal with feed and fodder resources, institutions like IGFRI, Jhansi and NIANP, Banglore have been established.

Species of associated biodiversity at risk of loss

In this section the objective is to identify species of associated biodiversity within the country that are at significant risk of loss, degradation or extinction.

29. List in Table 11 any components of associated biodiversity for which there is evidence of a significant threat of extinction or of the loss of a number of important populations in your country. Specify the degree of the threat according to the classification in use in your country or following the IUCN Red List Categories and Criteria. Include a description of the threat and list references or sources of information if available.

Table 11. Main threats to associated biodiversity identified as at risk.

Associated biodiversity species	**Degree of threat**	**Main threat**	**References or sources of information if available**
Indian Vultures (Gyps indicus and others) White-backed Vulture (Gyps bengalensis), Slender billed Vulture (Gyps tenuirostris), Long billed Vulture (Gyps indicus),	Endangered to critical	Diclofenac salt, indiscriminately used in livestock treatment causing the kidney damage in vultures	1. Action Plan for Vulture Conservation in India (2006), Min. of Environment & Forests, Govt. of India http://www.moef.nic.in/ 2. Green, et al. (2004). "Diclofenac poisoning as a cause of vulture population declines across the Indian subcontinent". Journal of Applied Ecology 41 (5). Other related publications and reports.
Local species of dammer bees in the North eastern region of india	More than 50%	Hunting and destruction of nesting sites	

Associated biodiversity species	Degree of threat	Main threat	References or sources of information if available
Clarias magur	High	Habitat degradation, Overfishing, Pesticide usage in agriculture fields	
Schizothorax richardsonii	Moderate	Habitat degradation	
Tor putitora	High	Habitat degradation, Overfishing, use of explosives	
Tor tor	Moderate	Habitat degradation, Overfishing	
Tor khudree	High	Habitat degradation, Overfishing, use of explosives	
Ompok pabda	Moderate	Habitat degradation, Overfishing, Pesticide usage in agriculture fields	
Chitala chitala	Moderate	Habitat degradation, Overfishing	
Wallago attu	Moderate	Habitat degradation, Overfishing	
Horabagrus brachysoma	Moderate	Habitat degradation, Overfishing	

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Conservation of associated biodiversity

This section collects information on the state of conservation of components of associated biodiversity providing ecosystem services within production systems in your country.

30. Does your country currently have any *ex situ* conservation or management activities or programmes for associated biodiversity for food and agriculture? These may include, for example, culture collections, collections of pollinators, etc. If so, list these in Table 12.

Table 12. *Ex situ* conservation or management activities or programmes for associated biodiversity for food and agriculture.

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation conditions	Objective(s)	Characterization and evaluation status
Plants	1584 species	427756	LTS, In-vitro, Cryo, FGB	Conservation for long term use and sustainable utilization	
Vertebrates	Indian Vultures White-backed Vulture (Gyps bengalensis), Slender billed Vulture (Gyps tenuirostris), Long billed Vulture (Gyps indicus),	In hundreds,	Captive breeding with sign of increasing population	To conserve different species of Indian vultures	NK

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation conditions	Objective(s)	Characterization and evaluation status
Invertebrates	Trichogramma chilonis Trichogramma japonicum Trichogramma achaeae Trichogramma cacoceae Trichogramma embryophagum Trichogramma pretiosum Trichogramma brassicae (NBAIR, Bangalore)	Nucleus cultures	Cultured in eggs of Corcyra cephalonica In ambient conditions in laboratory	Supply to farmers / comeercial producers / scientists for biological control of crop pests	
Invertebrates	Trichogrammatoidea bactrae (NBAIR, Bangalore)	Nucleus culture	Cultured in eggs of Corcyra cephalonica In ambient conditions in laboratory	Supply to farmers / comeercial producers / scientists for biological control of crop pests	
Invertebrates	Chrysoperla zastrowi sillemi (NBAIR, Bangalore)	Nucleus culture	Cultured on eggs of C. cephalonica , Ambient conditions in laboratory	Supply to farmers / comeercial producers / scientists for biological control of crop pests	
Invertebrates	Cryptolaemus montrouzieri (NBAIR, Bangalore)	Nucleus culture	Cultured on mealybugs Ambient conditions in laboratory	Supply to farmers / comeercial producers / scientists for biological control of crop pests	
Micro-organisms	Bacillus thuringiensis (NBAIR, Bangalore)				
Micro-organisms	Beauveria bassiana (NBAIR, Bangalore)				
Micro-organisms	Metarhizium anisopliae (NBAIR, Bangalore)				
Micro-organisms	Heterorhabditis indica (NBAIR, Bangalore)		Cultured in larvae of Galleria melonella		
Micro-organisms	Steinernema carpocapsae (NBAIR, Bangalore)		Cultured in larvae of Galleria melonella		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation conditions	Objective(s)	Characterization and evaluation status
Micro-organisms	NAIMCC, Mau Bacteria, archeae, actinomycetes, fungi including mushrooms and cyanobacteria	6157	Preservation of microorganisms through long-term and short-term methods.	To conserve microbial wealth of India in order to utilize in agriculture and allied sectors	Trait-specific microbes are preserved for development microbe-based technology.
Micro-organisms	MTCC, Chandigarh Bacteria, archeae, actinomycetes and fungi	12000	Preservation of microorganisms through long-term and short-term methods.	To conserve microbial wealth of India in order to utilize in agriculture and allied sectors	Trait-specific microbes are preserved for development microbe-based technology.
Micro-organisms	MCC, Pune Bacteria and fungi	2500	Medium-and long-term storage	Utilization for food and other products of industrial importance	Trait-specific microbes are preserved for development microbe-based technology.
Micro-organisms	ITCC, New Delhi Fungi	3,800	Preservation of microorganisms through long-term and short-term methods.	To conserve microbial wealth of India in order to utilize in agriculture and allied sectors	Trait-specific microbes are preserved for development microbe-based technology.
Micro-organisms	CCUBGA, New Delhi Cyanobacteria	500	Active growth	To conserve microbial wealth of India in order to utilize in agriculture and allied sectors	Trait-specific microbes are preserved for development microbe-based technology.
Micro-organisms	DMR, Solan	2500	Short-term and medium term storage	To conserve microbial wealth of India in order to utilize in agriculture and allied sectors	Trait-specific microbes are preserved for development microbe-based technology.
Vertebrates	Labeo rohita	200	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Cirrhinus mrigala	100	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Labeo fimbriatus	50	Cryopreservation of milt	Long term conservation and breeding	Y

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation conditions	Objective(s)	Characterization and evaluation status
Vertebrates	Labeo calbasu	50	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Labeo dussumieri	20	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Labeo dyocheilus	20	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Labeo dero	20	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Tenualosa ilisha	20	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Ompok malabaricus	20	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Shizothorax richardsonii	10	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Tor putitora	50	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Tor khudree	20	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Clarias magur	20	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Heteropneustes fossilis	10	Cryopreservation of milt	Long term conservation and breeding	Y
Vertebrates	Horabagrus brachysoma	30	Cryopreservation of milt	Long term conservation and breeding	Y

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31. Does your country currently have any *in situ* conservation and management activities or programmes in your country that support the maintenance of associated biodiversity? If so provide any available information on organisms and species managed or conserved, site name and location, production system(s) involved, conservation objective and specific actions that secure associated biodiversity or ecosystem services (if any).

Table 13. *In situ* conservation or management activities or programmes for associated biodiversity for food and agriculture.

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Areca triandra, Boehmeria nivea (wild form), Citrus medica, Mangifera andamanica, M. camptosperma, M. sylvatica, Vigna marina, Vanilla andamanica; Elaeocarpus, Tinospora, Haematocarpus, Garcinia, Grewia, Salacia, Ziziphus, Nephelium, Buchanania, Canavalia, Sesbania, Rubus, Syzygium, Coccinia, Morinda, Rauvolfia, Ocimum, Piper, Myristica, Cinnamonum, Baccaurea, Artocarpus, Zingiber, Musa, Dioscorea, Colocasia, Coix	Great Nicobar Biosphere Reserve, Andaman and Nicobar Islands	F1 [Naturally regenerated forests: Tropics]	Biosphere Reserves roughly corresponding to IUCN Category V Protected Areas. It often includes one or more National Parks and/or Wildlife Sanctuaries -to serve as a wider base for conservation of entire range of living resources -to bring out representative ecosystems under conservation and sustainable use on long basis -to ensure participation of local people for effective management and advise on means of improving livelihood of local inhabitants through sustainable use - to integrate scientific research with traditional knowledge of conservation, education and training	• Stringent security • Not allowing for any collection /destruction • Inventorisation of biodiversity; frequent monitoring of changes in population • Protection for flora, fauna, and also human communities inhabited in these regions • Awareness generation to local people about importance of biodiversity

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Wild species of Curcuma, Dioscorea, Piper, Zingiber, Vigna, Sesamum, Abelmoschus, Cajanus, Dunbaria, Rhynchosia and Amaranthus Dillenia indica, Maerua oblongifolia, Shorea robusta, Kydia calycina, Aglaia elaeagnoidea, Melia dubia, Alysicarpus longifolius, Crotolaria globosa, C. lunulata, C. quinquefolia, Acacia eburna, Salvadora persica, Tylophora fasciculata, Cordia gharaf, Solanum trilobatum, Butea monosperma, Rhynchosia heynei, Rauvolfia serpentina, Aegle marmelos, Rubia cordifolia, Gymnema sylvestre, Oroxylum indicum, Phyllanthus indofischeri, Gloriosa superba, Celastrus paniculatus, Pueraria tuberosa, Holostemma adakodien, Costus speciosus, Pterocarpus santalinus, Rhynchosia beddomei, Syzygium alternifolium, Cycas beddomei, Pimpinella tirupatiensis	Seshachalam Biosphere Reserve in Chittoor and Cuddapah districts of Andhra Pradesh	F1 [Naturally regenerated forests: Tropics]	-do-	-do-

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Allium pratti, A. rhabdotum, Cajanus spp., Camellia siangensis, Citrus ichangensis, C. medica, Coptis teeta, Dioscorea pentaphylla, D. wallichii, D. prazeri, D. wattii, Musa spp., Piper attenuatum, P. sylvaticum, P. hamiltonii, P. peepuloides, Prunus spp., Rubus spp., Zingiber spp. Sapindus mukrosii, Rhododendron spp., Castanopsis indica, Populus gamblei, Rosa, Aconitum ferox, Aconitum nagarum, Amaranthus hybridus, Chenopodium album, Trichosanthes cordata, Dioscorea bulbifera, Musa velutina, Musa acuminata, Musa sapientum, Rubus insignis, Zanthoxyllum rhetse, Solanum kurzii, Zingiber zerambet, Acorus calamus, Eryngium foetidum, Centella asiatica, Colocasia esculenta, Canarium strictum, Terminalia chebula, Terminalia bellerica, Costus speciosus, Dioscorea alata, Elaeocarpus aristatus, Vitex negundo, Cinnamomum zeylenicum, Litsea cubeba Cinnamomum tamala Murraya paniculata, Musa velutina, Piper betel, Plantago erosa, Dendrocalamus strictus, Aconitum heterophyllum, Rubia manjith, Clendrodendrum colebrookianum	Dihang-Dibang Biosphere Reserve, in Dibang Valley, Upper Siang, and West Siang districts	F3 [Naturally regenerated forests: Temperate]		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Abelmoschus manihot (pungens forms), Camellia kissi, C. sinensis var. assamica, Citrus spp., Cucumis hystrix, Curcuma aromatica, C. amada, Dioscorea spp., Musa spp., Piper spp., Zingiber intermedium, Z. rubens, Z. spectabilis, Saccharum spp. Salix tetrasperma, Dillenia indica, Terminalia myriocarpa, Erianthus ravennae, Saccharum procerum, S. spontaneum, Cinnamomum bejolghota, Rauvolfia serpentina, Zingiber zerumbet, Catharanthus roseus, Cordia dichotoma, Euryale ferox, Trapa, Dioscorea alata, D. bulbifera, Hydnocarpus kurzii	Dibru-Saikhowa Biosphere Reserve in Tinsukhia and Dibrugarh districts of Assam	F2 [Naturally regenerated forests: Subtropics]	-do-	-do-
Plants	Artocarpus hirsutus, Schleichera oleosa, Grewia tiliifolia, Pterocarpus marsupium, Bambusa bamboos, Dendrocalamus strictus, Syzygium spp., Cinnamomum spp., Myristica spp., Piper spp., Elettaria cardamomum, Cassia fistula, Phyllanthus emblica, Terminalia chebula, T. bellerica, Asparagus racemosus, Hemidesmus indicus, Rauvolfia serpentina, Canarium strictum, Garcinia morella, Garcinia gummi-gutta, Cinnamomum sulphuratum	Nilgiri Biosphere Reserve in states of Tamil Nadu, Kerala and Karnataka	F1 [Naturally regenerated forests: Tropics]	-do-	-do-

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Abelmoschus tuberculatus, Citrus medica, Cucumis setosus, Solanum incanum, S. insanum, Vigna sublobata; wild forms of Panicum sumatrense, Paspalum scorbiculatum, Vigna umbellata Gloriosa superba, Gymnema sylvestre, Dioscorea bulbifera, Dioscorea spp., Acorus calamus, Alangium salviifolium, Buchanania lanzan, Chlorophytum borivilianum, Curculigo orchiodes, Curcuma angustifolia, Curcuma aromatica, Rauvolfia serpentina, Strychnos nux-vomica, Andrographis paniculata, Asparagus racemosus, Bacopa monnieri, Centella asiatica, Aegle marmelos, Pterocarpus marsupium, Hemidesmus indicus, Plumbago zeylanica,Terminalia arjuna, Terminalia bellerica, Terminalia chebula, Tinospora cordifolia, Tylophora asthmatica, Vitex negundo, Withania somnifera, Zingiber officinale Vitex negundo, Phyllanthus amarus, Solanum nigrum	Pachmahri Biosphere Reserve, Hoshangabad district of Madhya Pradesh	F2 [Naturally regenerated forests: Subropics]		
Plants	Camellia caduca, Citrus indica, C. latipes, C. medica, Cucumis hystrix, Prunus jenkinsii, Vigna umbellata (wild form)	Nokrek Biosphere Reserve, West, East and South Garo Hills districts, Meghalaya	F2 [Naturally regenerated forests: Subropics]		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Abelmoschus crinitus, A. tetraphyllus, Piper longum, P. trioicum, Solanum insanum, S. torvum, S. viarum, Dioscorea pentaphylla, D.bulbifera, D. puber, D. oppositifolia, Costus speciosus, Ziziphus fruticosa, Z. nummularia, Z. oenoplia, Z. xylopyrus Saraca asoca, Andrographis paniculata, Asparagus racemosus, Celastrus paniculatus, Centella asiatica, Cordia macleodii, Chlorophytum tuberosum, Costus specious, Curculigo orchioides, Cymbopogon flexuosus, Hemidesmus indicus, Terminalia arjuna, T.bellirica, T. chebula, Nyctanthes arbortristis, Pterocarpus marsupium, Pueraria tuberosa, Rubia cordifolia, Oroxylum indicum, Rauvolfia serpentina, Gloriosa superba, Solanum surattense, Strychnos nux-vomica, Swertia angustifolia, Vitex peduncularis, Woodfordia fruticosa, Oryza offi cinalis, Oryza granulata	Similipal Biosphere Reserve, Mayurbhanj district, Odisha	F2 [Naturally regenerated forests: Subropics]		
Plants	Abelmoschus angulosus (3 taxa), Cajanus lineatus, Solanum insanum, S. multiflorum, Oryza meyeriana subsp. granulata, Trichosanthes cucumerina subsp. villosula, T. nervifolia, Vigna sublobata Trichopus zeylanicus, Myristica spp., Garcinia imberti, Madhuca bourdillonii, Syzygium bourdillonii Andrographis spp.	Agasthyamala Biosphere Reserve in Tamil Nadu and Kerala	F1 [Naturally regenerated forests: Tropics]		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Allium stracheyi, Aconitum balfourii, A. heterophyllum, Angelica glauca, Arnebia benthamii, Dactylorhiza hatagirea,Hedychium spicatum, Paeonia emodi, Picrorhiza kurrooa, Podophyllum hexandrum, Saussurea costus, S. obvallata,Taxus baccata	Nanda Devi Biosphere Reserve IN Chamoli, Bageshwar and Pittoragarh districts of Uttarakhand	F3 [Naturally regenerated forests: Temperate]		
Plants	Zizyphus jujuba, Sesamum spp., Porteresia coarctata, Vigna trilobata, Solanum surrattensis, Citrullus colocynthis, Borassus flabellifera	Gulf of Mannar Biosphere Reserve, Tamil Nadu	F1 [Naturally regenerated forests: Tropics]		
Plants	Rauvolfia serpentina, Oroxylum indicum, Paspalum longifolium var. lorirhachis, Garcinia spp., Terminalia chebula, Syzygium cumini, S. formosum, S. oblatum, Bauhinia purpurea, Cinnamomum tamala, Bombax ceiba, Ficus roxburghii, Gmelina arborea, Dillenia indica, D. pentagyna, Musa balbisiana, Spondias pinnata Saccharum narenga, Vetiveria zizanioides	Manas Biosphere Reserve in Kokrajhar, Chirang, Baksa, Udalguri, and Darrang districts of Assam	F2 [Naturally regenerated forests: Subtropics]		
Plants	Oryza spp., Nypa fruticans, Porteresia coarctata, Grewia, tetraphyllus, Piper longum, Solanum insanum, Ziziphus fruticosa, Z. nummularia, Z. oenoplia, Z. xylopyrus Andrographis paniculata, Oryza officinalis, Oryza meyeriana subsp. granulata	Sunderban Biosphere Reserve, 24-Parganas dist., West Bengal	F2 [Naturally regenerated forests: Subtropics]		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Aconitum ferox, A. heterophyllum, Bergenia ciliata, Dactylorhiza hatagirea, Nardostachys jatamansi, Panax pseudoginseng, Swertia chirayita, Taxus baccata, Dioscorea bulbifera, Allium wallichii, Zanthoxylum spp., Podophyllum hexandrum, Picrorhiza kurrooa, Rhododendron arboreum, R. anthopogon, Podophyllum sikkimensis	Khangchendzonga Biosphere Reserve, West Sikkim, Sikkim	F3 [Naturally regenerated forests: Temperate]		
Plants	Madhuca indica, Buchanania lanzan, Emblica officinalis, Tamarindus indicus, Rauvolfia serpentina, Acorus calamus¸ Abelmoschus tuberculatus, Solanum insanum, Vigna sublobata; wild forms of Panicum sumatrense, Paspalum scorbiculatum, Vigna umbellata	Achanakmar Amarkantak Biosphere Reserve in Chhattisgarh and Madhya Pradesh	F2 [Naturally regenerated forests: Subtropics]		
Plants	Suaeda spp., Atriplex spp., Aeluropus lagopoides, Sporobolus helvolus, Capparis, Salvadora, Tamarix, Prosopis chilensis, Acacia, Ziziphus nummularia, Commiphora wightii, Citrullus colocynthis	Kachchh Biosphere Reserve, Kutch dist., Gujarat	F2 [Naturally regenerated forests: Subtropics]		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Plants	Elymus, Leymus, Hordeum, Hippophae salicifolia, Hippophae rhamnoides subsp. turkestanica, Tanacetum tibeticum, Carum carvi, Lepidium apetalum, Peganum harmala, Oxyris digyna, Sedum ewersii, Dianthus anatolicus, Sedum tibeticum, Aconitum violaecum, Picrorhiza kurrooa, Swertia petiolata, Rheum tibeticum, Podophyllum hexandrum, Cicer microphyllum, Achillea millifolium, Thymus linearis, Origanum vulgare, Pennisetum lanatum, Phleum alpinum, Poa alpina, P. tibetica, Rosa webbiana, Ephedra gerardiana, Artemisia maritima, Bergenia stracheyi, Ferula jaeschkeana, Gentiana kurroo, Hippophae tibetana, Hyoscyamus niger, Saussurea costus, S. obvallata, Nardostachys grandiflora, Linum perenne, Prunus mira	Cold Desert Biosphere Reserve, Lahaul & Spiti district of Himachal Pradesh	F3 [Naturally regenerated forests: Temperate]		
Plants	Chlorophytum tuberosum, Gloriosa superba, Acorus calamus, Tinospora cordifolia, Aegle marmelos, Pterocarpus marsupium, Terminalia arjun, Centella asiatica, Plumbago zeylanica, Terminalia chebula, Maduca indica, Gymnema sylvestre, Withania somnifera, Adathoda vasica, Andrographis paniculata, Vitex negundo, Curculigo orchiodes, Aloe vera, Asparagus racemosus, Emblica officinalis	Panna Biosphere Reserve in Panna and Chhatarpur districts of Madhya Pradesh	F2 [Naturally regenerated forests: Subtropics]		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name)	Conservation objective(s)	Specific actions that secure associated biodiversity or ecosystem services
Vertebrates	Catla catla	Ganga River, Uttar Pradesh	Self Recruiting Capture fisheries-Subtropics	To support self recruitment	Breeding and Ranching
Vertebrates	Labeo rohita	Ganga River, Uttar Pradesh	Self Recruiting Capture fisheries-Subtropics	To support self recruitment	Breeding and Ranching
Vertebrates	Cirrhinus mrigala	Ganga River, Uttar Pradesh	Self Recruiting Capture fisheries-Subtropics	To support self recruitment	Breeding and Ranching
Invertebrates	Labeo calbasu	Dudhwa Sanctuary, Uttar Pradesh	Self Recruiting Capture fisheries-Subtropics	To support self recruitment	Breeding and Ranching
Vertebrates	Labeo bata	Samaspur Bird Sanctuary, Uttar Pradesh	Self Recruiting Capture fisheries-Subtropics	To support self recruitment	Breeding and Ranching
Vertebrates	Labeo dyocheilus	Dudhwa Sanctuary, Uttar Pradesh	Self Recruiting Capture fisheries-Subtropics	To support self recruitment	Breeding and Ranching
Vertebrates	Tor khudree	Lonavala, Maharashtra	Self Recruiting Capture fisheries-Subtropics	To support self recruitment	Breeding and Ranching
Vertebrates	Tor tor	Lonavala, Maharashtra	Self Recruiting Capture fisheries- Tropics	To support self recruitment	Breeding and Ranching
Vertebrates	Etroplus suratensis	Vembanad Lake, Kerala	Self Recruiting Capture fisheries- Tropics	To support self recruitment	Breeding and Ranching
Vertebrates	Horabagrus brahysoma	Vembanad Lake, Kerala	Self Recruiting Capture fisheries- Tropics	To support self recruitment	Breeding and Ranching
Vertebrates	Labeo dussumieri	Vembanad Lake, Kerala	Self Recruiting Capture fisheries- Tropics	To support self recruitment	Breeding and Ranching
Invertebrates	Macrobrachium rosenbergii	Vembanad Lake, Kerala	Self Recruiting Capture fisheries- Tropics	To support self recruitment	Breeding and Ranching

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32. What activities are undertaken in your country to maintain traditional knowledge of associated biodiversity? Has traditional knowledge of associated biodiversity been used to inform conservation and use decisions in your country? Please share best practices and lessons learned.

In India traditional knowledge is generally associated with biological resources and is invariably an intangible component of such a biological resource. Traditional knowledge(TK) has the potential of being translated into commercial benefits by

providing leads/ clues for development of useful practices and processes for the benefits of mankind and plays an important role in the economic and social life of India. The TK or indigenous knowledge can be found in multitude field such as nutrition, agriculture and fisheries, human health, veterinary care, handicrafts, performing arts, folk songs, religion and astrology, and many other day to day customs and practices. In India activities of TK for natural resource management are watershed development concept, village boundaries, irrigation, water harvesting, management of drinking water and water based industries. India is also a vast repository of traditional knowledge associated with biological resources. National Innovation Foundation (NIF) was launched in 2000 by the Government of India as India's national Initiative to strengthen the Grassroots technological innovations and Traditional Knowledge. Documentation of traditional knowledge is also acknowledged as a means of giving due recognition to the traditional knowledge holders. This particular aspect of documenting formulations in the Ayurvedic system of medicine in India in the shape of Traditional Knowledge Digital Library (TKDL). Some relevant laws regarding protection of traditional knowledge are Geographical Indication of Goods (Registration and Protection) Act, 1999,The Protection of Plant varieties and farmers' rights Act, 2001,The Biological Diversity Act, 2002, The Patent Act (2nd Amendment) Act, 2002.
The best example is Turmeric (Curcuma longa) being used as spice, medicines, cosmetics and as a color dye. Another example is "Jeevani" - a restorative, immuno-enhancing, antistress and anti-fatigue agent, based on the herbal medicinal plant arogyapaacha, used by the Kani tribals of the Western Ghats in the state of Kerala

Traditional knowledge of bee keeping, lac production are being practiced by some of the tribes in the country which are helping in conservation of several types of dammer bees. Insects are used in medicines by several tribes in the North east.

The microorganisms associated with fermented food items and dairy products which are part of traditional knowledge is being practiced. Some of the associated microorganisms like Lactobacillus, Streptococcus etc are being conserved at NBAIM and NDRI Karnal.

National Bureau of Fish Genetic Resources, Lucknow in collaboration with other institutions have documented various indigenous knowledge systems related to fisheries and their conservation. Traditional knowledge of fisher folks have been documented in major aquatic ecosystems across the country by different institutions. Several traditional and religious practices are being used by tribal and other local communities which help in conservation of resources.

33. Provide any available information on gender dimensions with respect to the maintenance of and knowledge about associated biodiversity. These may include differences in the roles and insights of women and men with respect to maintaining particular resources, monitoring their state, overseeing their management at different stages of production or ecosystem management.

Women and men conserve and use biodiversity resources differently and have different knowledge and needs with regard to biodiversity. Men's and women's involvement in biodiversity management are associated with their livelihoods, cultural, social & environmental needs. The contributions of women and men to agricultural production are often divided along gender lines, with important implications for sustainable agricultural practices and biodiversity conservation. Men are generally responsible for land preparation, such as clearing and soil tilling, while women are responsible for sowing, hoeing, crop maintenance, harvesting, food processing, storage and seed selection for future planting. Women are traditional caretakers of genetic and species diversity in agriculture; men are more often concerned with converting these resources into cash. In 1997, the Indian non-governmental organization (NGO), the M.S. Swaminathan Research Foundation (MSSRF), with support from the Food and Agriculture Organization of the United Nations (FAO), conducted a research project on Gender Dimensions in Biodiversity Management in different locations throughout India, focusing primarily on gender roles in agro-biodiversity. Gender roles particularly in the areas of plant and seed selection and preservation. Women's role in biodiversity conservation has been overlooked, despite the fact that women have a profound knowledge of plants and animals in their environment. Although the natural resources of the environment provide the basis for both women's and men's livelihoods, women have traditionally used a variety of indigenous plants, trees and animals and so have a direct stake in their preservation

Role and perception of women towards fisheries resources have been documented in various aquatic production systems. Access of women to aquatic resources and their contributions in resource management have also been documented. Efforts have also been made to increase awareness of women fisher folk towards sustainable utilization of fisheries resources.

34. **Provide in Table 14 a list of wild food species known to be harvested, hunted, captured or gathered for food in your country, and that are not already included in a completed or ongoing Country Report on Forest, Aquatic, Animal or Plant Genetic Resources. Indicate in or around which production system the species is present and harvested, and the change in state of the species over the last 10 years (strongly increasing (2), increasing (1), stable (0), decreasing (-1), or strongly decreasing (-2), or not known (NK)). Indicate where differences within species have been identified and characterized.**

Table 14. Wild species used for food in the country.

Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Change in state (2,1,0,-1,-2, NK)	Differences within species identified and characterized (Y/N)	Source of information
Bael	Aegle marmelos (L.) Correa	F1, F2; dry deciduous forests	-1	Y	Wealth of India (1948-92); Ambasta et al. (1986); Arora and Pandey (1996)
Zimmu	Aegle marmelos (L.) Correa	F1, F2; dry deciduous forests	-1	N	
Boro mankachu	Alocasia macrorrhiza Schott	F1, F2; humid tracts	0	N	
Chaulai	Amaranthus spp. (blitum, tricolor, graecizans)	F1, F2; weedy in disturbed areas	0	Y	
Kathal	Artocarpus heterophyllus Lam.	F1, F2; evergreen forests	-1	N	
Barhal	Artocarpus lakoocha Roxb.	F2; evergreen, semi-evergreen and moist deciduous forests	-1	N	
Bans	Bambusa spp. (arundinacea, spinosa, vulgaris)	F1, F2; deciduous and evergreen forests	-1	Y	
Kachnar	Bauhinia variegata L.	F1, F2; humid and subhumid areas	NK	N	
Chironji	Buchanania lanzan Spreng.	F1, F2; dry deciduous forests	-1	N	
Ker	Capparis decidua Edgew.	F1, F2; drier tracts	0	N	
-	Caralluma spp. (edulis, adscendens)	F1, F2; dry habitats	-1	N	
Karonda	Carissa congesta Wight	F1, F2; subhumid, rocky areas	-1	Y	
Bathua	Chenopodium album L.	F2, F3; weedy in disturbed areas	+1	Y	
Kundri	Coccinia cordifolia Cogn.	F1, F2; most areas	0	Y	
Adlay	Coix lacryma-jobi L.	F1, F2; moist areas	NK	Y	
Arbi	Colocasia esculenta (L.) Schott	F1, F2; humid, water-logging conditions	0	Y	

Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Change in state (2,1,0,-1,-2, NK)	Differences within species identified and characterized (Y/N)	Source of information
Lasora	Cordia dichotoma Forst.f.	F1, F2; esp. in dry areas	0	Y	
Bans	Dendrocalamus hamiltonii Nees & Arn. ex Munro	F2; deciduous and evergreen forests	-1	N	
Raishan	Digitaria cruciata (Nees) A.Camus	F1, F2; grasslands	-1	N	
Chupri alu	Dioscorea alata L.	F1, F2; humid and semi-evergreen forests	-1	Y	
Sirshing	Elaeagnus angustifolia L.	F3	-1	N	
Makhana	Euryale ferox Salisb.	F2; in water bodies	-1	Y	
Kait	Feronia limonia (L.) Swingle	F1, F2; dry areas	-1	N	
Soh-phlang	Flemingia vestita Benth. ex Baker	F2; in forest openings and grassy patches	-1	Y	
Kokam	Garcinia indica Choisy	F1; rain forests	-1	N	
Phalsa	Grewia subinaequalis DC.	F1, F2; mixed forests	NK	Y	
Sirma	Hippophae rhamnoides L.	F3; river beds, open stony alpine scrub vegetation	-1	Y	
Kalmisag	Ipomoea aquatica Forsk.	F1, F2; occurs in pods and streams	0	N	
Lapha	Malva verticillata L.	F3; grassy meadows	NK	N	
Khirni	Manilkara hexandra (Roxb.) Dubard	F1, F2; dry evergreen forests	-1	N	
Sanjina	Moringa oleifera Lam.	F1, F2; semi wild	-1	Y	
Shehtut	Morus alba L.	F1, F2; in disturbed areas	+1	Y	
Kaiphal	Myrica esculentus Buch.-Ham.	F2; in Himalaya	-1	N	
Piriya halim	Nasturtium officinale R.Br.	F2, F3; in ditches, pools, margins of shallow streams	0	N	
Kamal	Nelumbo nucifera Gaertn.	F1, F2; in lakes and ponds	-1	Y	
Bhanjira	Perilla frutescens (L.) Britton	F3; weedy in disturbed areas	0	Y	
Jungli khajur	Phoenix sylvestris Roxb.	F1, F2; in drier areas	-1	N	
Aonla	Phyllanthus emblica L.	F1, F2; mixed deciduous forests	-1	Y	
Matazor	Phytolacca acinosa Roxb.	F3; in open forests	-1	N	

Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Change in state (2,1,0,-1,-2, NK)	Differences within species identified and characterized (Y/N)	Source of information
Chilgoza	Pinus gerardiana Wall.	F3	-1	N	
Kulfa sag	Portulaca oleracea L.	F1, F2; weedy in disturbed areas	0	Y	
Dieng-soh-satang-hi	Prunus jenkinsii Hook.f.	F2	-1	N	
Saiong	Prunus napaulensis Steud.	F3	-1	N	
Anar	Punica granatum L.	F2; scrub forests in Himalaya	-1	Y	
Kainth	Pyrus pashia Buch.-Ham. ex D.Don	F3; open sunny slopes	-1	N	
Hinsalu	Rubus spp. (ellipticus, niveus, moluccanus)	F2, F3	0	N	
Rangrek	Sorbus aucuparia L.	F3	-1	N	
Jamun	Syzygium cumini (L.) Skeels	F1, F2; along streams, damp places and swamps	-1	Y	
Imli	Tamarindus indica L.	F1, F2; drier areas	-1	Y	
Singhara	Trapa natans L.	F1, F2; in lakes, tanks and ponds	-1	Y	
Jermei-soh-lang-tor	Vigna vexillata (Benth.) A.Rich	F1, F2; scrub/evergreen open forests	-1	Y	
Ber	Ziziphus mauritiana Lam.	F1, F2; drier areas	0	Y	
Wild silk worm		Collected from nature			
Pine caterpillars		Collected from nature			
Termites and Termite queen	Odontotermis sp.	Collected from nature			
Several species of vasps.	Vespa cincta	Collected from nature			
Eri silk moth	Samia cynthia	Collected from the wild	-1		
Red ant	Oecophylla smaragdina	Collected from the wild	0		
Flammulina	Flammulina	Cultivated on wheat straw	1	Y	AMAAS Project
Macrocybe	Macrocybe gigantea	Cultivated on wheat straw	1	Y	AMAAS Project
Hericium	Hericium spp	Saw dust	1	Y	AMAAS Project
Psilocybe	Psilocybe	Wheat and paddy straw	1	Y	AMAAS Project
Calocybe	Calocybe indica	Wheat straw under high temperature	1	Y	AMAAS Project

Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Change in state (2,1,0,-1,-2, NK)	Differences within species identified and characterized (Y/N)	Source of information
Hilsa	Tenualosa ilisha	Self recruiting capture fisheries- Tropics	-1	Y	NBFGR, CIFRI
Magur	Clarias magur	Self recruiting capture fisheries- Tropics	-2	Y	NBFGR, CIFRI
Singhi	Heteropneustes fossilis	Self recruiting capture fisheries- Tropics	-1	N	NBFGR, CIFRI
Pearlspot	Etroplus suratensis	Self recruiting capture fisheries- Tropics	0	N	NBFGR
Mullet	Mugil cephalus	Self recruiting capture fisheries- Tropics	-1	N	NBFGR
Mahseer	Tor putitora, Tor khudree, Tor tor	Self recruiting capture fisheries- Subtropics	-1	Y	NBFGR
Snow trout	Schizothorax richardsonii	Self recruiting capture fisheries- Temperate	-1	N	DCFR
Chital	Chitala chitala	Self recruiting capture fisheries- Tropics	-1	Y	NBFGR
Seenghala	Sperata seenghala	Self recruiting capture fisheries- Tropics	0	N	NBFGR
Kalbasu	Labeo calbasu	Self recruiting capture fisheries- Tropics	0	Y	NBFGR
Sardine	Sardinella longiceps	Self recruiting capture fisheries- Tropics	-2	N	NBFGR, CMFRI
Mackeral	Rastrelliger kanagurta	Self recruiting capture fisheries- Tropics	0	N	NBFGR, CMFRI
Tuna	Thunnus spp.	Self recruiting capture fisheries- Tropics	0	N	NBFGR, CMFRI
Seabass	Lates calcarifer	Self recruiting capture fisheries- Tropics	0	N	NBFGR, CIBA
Milkfish	Chanos chanos	Self recruiting capture fisheries- Tropics	0	N	CIBA, CMFRI
Grouper	Epinephelus spp.	Self recruiting capture fisheries- Tropics	0	N	CMFRI
Sharks	Carcharhinus spp., Alopius spp.	Self recruiting capture fisheries- Tropics	0	N	CMFRI
Rays	Himandura spp., Pastinachus spp.	Self recruiting capture fisheries- Tropics	0	N	CMFRI
Seer fish	Scomberomorus commerson	Self recruiting capture fisheries- Tropics	0	N	NBFGR, CMFRI
Sciaenids	Johnius spp.	Self recruiting capture fisheries- Tropics	0	N	CMFRI
Shrimps	Penaeus spp.	Self recruiting capture fisheries- Tropics	-1	Y	CMFRI, NBFGR
Mud crab	Scylla serrata	Self recruiting capture fisheries- Tropics	0	N	NBFGR, CIBA, CMFRI
Lobsters	Panulirus homarus	Self recruiting capture fisheries- Tropics	0	Y	NBFGR, CMFRI
Mussel	Perna viridis	Self recruiting capture fisheries- Tropics	-1	Y	NBFGR, CMFRI

Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Change in state (2,1,0,-1,-2, NK)	Differences within species identified and characterized (Y/N)	Source of information
Pomfrets	Pampus argenteus	Self recruiting capture fisheries- Tropics	-1	Y	NBFGR, CMFRI
Carangids	Caranx spp.	Self recruiting capture fisheries- Tropics	-1	N	
Cephalopod	Sepia spp.	Self recruiting capture fisheries- Tropics	-1	N	

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Wild food resources at risk

In this section the objective is to identify uncultivated and wild species used for food within the country that are at significant risk of loss.

35. **List in Table 15 any wild food species for which there is evidence of a significant threat of extinction or of the loss of a number of important populations in your country. Specify the degree of threat according to the classification in use in your country or following the IUCN Red List Categories And Criteria. Include a description of the threat and list references or sources of information if available.**

Table 15. Main threats to wild food species identified as at risk.

Wild food species (scientific name)	Degree of threat	Main threat	References or sources of information if available
Allium auriculatum Kunth	Endangered	Wild harvest for leaves in destructive manner	UNEP-WCMC (2011); http:// www.bsienvis.nic.in/RET/ RET_index.html
Allium loratum Baker	Endangered (in Jammu & Kashmir)	Narrow endemic; wild harvest for leaves in destructive manner	http://www.bsienvis.nic.in/RET/ RET_index.html
Allium macranthum Baker	Threatened	Narrow endemic; Wild harvest for leaves in destructive manner	http://envfor.nic.in/bsi/ research.html
Allium stracheyi Baker	Vulnerable (V)	Narrow endemic; wild harvest for leaves in destructive manner	http://www.bsienvis.nic.in
Artocarpus hirsutus Lam.	Threatened	Narrow endemic; minor fruit; Illegal felling for timber purpose	Kumar et al. (2012)
Buchanania lanzan Spreng.	Facing threat	Wild harvest for nut value, leaving a few nuts for regeneration in wild	Authors (pers. comm.)
Canarium strictum Roxb.	High conservation significance in Eastern Ghats and Threatened in Manipur	Minor fruit; Illegal felling for timber value and repellent use	http://www.bsienvis.nic.in/RET/ RET_index.html; Pragasan et al. (2008)
Ceropegia bulbosa Roxb. UNEP-	Vulnerable	Wild harvest for tubers in destructive manner	WCMC (2011)
Ceropegia hirsuta Wight & Arn.	Threatened in semi-arid zone	Wild harvest for tubers in destructive manner	Kotia et al. (2008)
Ceropegia lawii Hook.f.	Endangered (E)	Wild harvest for tubers in destructive manner	http://www.bsienvis.nic.in

Wild food species (scientific name)	Degree of threat	Main threat	References or sources of information if available
Ceropegia oculata Hook.	Rare (R)	Wild harvest for tubers in destructive manner	http://www.bsienvis.nic.in
Ceropegia pusilla Wight & Arn.	Rare (R)	Wild harvest for tubers in destructive manner	http://www.bsienvis.nic.in
Corylus jacquemontii Decne.	High conservation significance in Jammu Division of Jammu & Kashmir	Wild harvest for nut value, leaving a few nuts for regeneration in wild	Sharma (2008)
Elaeagnus conferta Roxb.	Rare (R)	Wild harvest for nut value	UNEP-WCMC (2011)
Elaeocarpus munroii Mast.	Rare (R)	Wild harvest for fruit value in destructive manner	http://www.bsienvis.nic.in
Elaeocarpus prunifolius Wall.	Rare (R)	Wild harvest for fruit value in destructive manner	http://www.bsienvis.nic.in
Flemingia vestita Benth. ex Baker	Rare (esp. domesticated populations)	Area under this minor tuber crop (domesticated populations) decline in Khasi Hills	Authors (pers. comm.)
Garcinia cowa Roxb. ex DC. a	Vulnerable in Odish	Wild harvest for fruit use	Biswal and Nair (2008)
Garcinia gummi-gutta (L.) Robson var. gummi-gutta	Facing threat	Wild harvest for fruit use	Malik et al. (2010)
Garcinia gummi-gutta (L.) Robson var. papilla (Wight) N.P.Singh	Facing threat	Narrow endemic	Malik et al. (2010)
Garcinia indica (Thouars) Choisy	Facing threat	Narrow endemic	Malik et al. (2010)
Hippophae rhamnoides L.	Facing threat	Wild fruit; exploited for fuel use as a few alternatives available in cold arid Himalaya	Authors (pers. comm.)
Pinus gerardiana Wall.	Facing threat	Wild harvest for nuts of high value, leaving a few nuts for regeneration in wild	Authors (pers. comm.)
Zanthoxylum rhetsa (Roxb.) DC.	Endangered in Andhra Pradesh and Vulnerable in Odisha	Poor natural regeneration	Biswal and Nair (2008)
Manilkara hexandra	Facing threat	Edible fruit harvested, hampering the regeneration	Malik et al. (2012)
Apis dorsata	severe	Hunting and burning gregarious colonies	
Oecophylla smaragdina) and other food insects	Severe (locally wherever threats in next column occur)	Habitat degradation: mining, logging, deforestation	
Cordyceps sinensis	High	Ecosystem disturbance	AMAAS Project
Tenualosa ilisha	Moderate	Habitat alterations	
Clarias magur	Moderate	Habitat loss	
Heteropneustes fossilis	Moderate	Habitat loss	
Lates calcarifer	High	Habitat alterations, over exploitation	
Mugil cephalus	Moderate	Habitat alterations, over exploitation	
Tor putitora	High	Habitat alterations, over exploitation	
Tor khudree	High	Habitat alterations, over exploitation	

Wild food species (scientific name)	Degree of threat	Main threat	References or sources of information if available
Tor tor	High	Habitat alterations, over exploitation	
Shizothorax richardsonii	Moderate	Habitat alterations, over exploitation	
Chitala chitala	High	Habitat loss, over exploitation	
Chanos chanos	Moderate	Over exploitation	
Pampus argentius	Moderate	Climate change, Over exploitation	
Sardinella longiceps	Moderate	Climate change, Over exploitation	
Rastrelliger kanagurta	Moderate	Climate change, Over exploitation	
Scylla serrata	Moderate	Habitat alterations, Over exploitation	

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Provide information, where available, as to how the loss of wild food species affects the livelihoods of those that depend on them and on the general impact of their loss on food security and nutrition. Include references to the sources of information, if possible.

Many of the wild mushrooms that grow in different parts of the country are a rich source of nutrients to the tribal population as well as people dwelling near forests. These mushrooms also have medicinal value.

Loss of wild food species leads to lower income to fishermen. Less production affects availability and affordability of consumers.

Conservation of wild resources used for food

36. **Are any *ex situ* conservation or management activities or programmes established in your country for wild food species? These may include, for example, culture collections, collections of insects, fungi, etc. If so, list these in Table 16.**

Table 16. *Ex situ* conservation or management activities or programmes for wild food species.

Wild food species conserved (scientific name)	Size of collection (number of accessions and quantities)	Conservation conditions	Objective(s)	Characterization and evaluation status
Chenopodium album, C. murale	123			
Fagopyrum emarginatum, Fagopyrum esculentum, Fagopyrum himalianum, Fagopyrum sp. Fagopyrum tataricum	994			
Citrullus vulgaris var. citroide, Citrullus colocynthis	146			
Coccinia grandis, Coccinia indica	34			
Buchanania axillaris, Buchanania lanzan, Buchanania latifolia	97			
Capparis decidus	23			

Wild food species conserved (scientific name)	Size of collection (number of accessions and quantities)	Conservation conditions	Objective(s)	Characterization and evaluation status
Mimusops elengi	16			
Carissa carandas, Carissa congesta, Carissa spinarum, Carissa spinosa	14			
Ziziphus mauritiana, Ziziphus mauritiana var. fruticosa, Ziziphus rugosa, Ziziphus xylopyrus	9			
Madhuca indica, Madhuca longifolia	8			
Prunus armeniaca, Cordia obliqua, Ficus bengalensis, Rubus macilentus, Rubus sp, Muntingia calabura, Capparis separia, Capparis spinosa, Eugenia uniflora, Citrus madurensis, Citrus sp., Ficus glomerata, Ficus racemosaAnnona glabra, Annona reticulata, Annona squamosa, Phoenix dactylifera, Phoenix humilis, Ficus carica, Ficus sp., Ficus hispida, Vitis latifolia, Grewia tiliaefolia, Corylus jacquementii, Prunus cornuta, Cordia dichotoma gürke, Cordia rothii, Limonia acidissima, Ziziphus oenoplia, Syzygium cumini, Schleichera oleosa, Schleichera trijuga, Cordia myxa, Cordia sp., Olea cuspidata, Olea europaea, Passiflora edulis, Passiflora sp., Diospyros lotus, Prunus sp., Punica granatum, Portium serratum, Ribes alpestre, Ribes glaciale, Ficus religiosa, Samadera indica, Passiflora foetida, Fragaria sp., Trewia nudiflora, Juglans sp., Prunus cerasoides, Phoenix sylvestris, Dioscorea pubera, Syzygium stocksii, Syzygium zeylanicum	105			

Wild food species conserved (scientific name)	Size of collection (number of accessions and quantities)	Conservation conditions	Objective(s)	Characterization and evaluation status
Agricus spp Lentinus squarrosulus Hericium spp Auricularia olivaceous Volvariella volvacea Calocybe indica Helvella villosa Entomolma sp Flammulina spp Catharellus applanatus C. elongatipes Paneolus sp Cystolepiota omerospora Petiota metulaespore Macrolepiota heimii Isaria sinclarii Psilocybe sp Leucoagricus sp Schizostoma sp Limacella sp Amanita spp Leucopaxillus sp Cordyceps	1000	Medium term storage	To utilize for the purpose of food, medicine, nutrition etc.	Evaluated for traits relating to food, nutrition and food.
Catla catla	200	Cryopreservation of milt	Long term conservation and breeding	Y
Labeo rohita	200	Cryopreservation of milt	Long term conservation and breeding	Y
Cirrhinus mrigala	100	Cryopreservation of milt	Long term conservation and breeding	Y
Labeo calbasu	50	Cryopreservation of milt	Long term conservation and breeding	Y
Labeo dussumieri	20	Cryopreservation of milt	Long term conservation and breeding	Y
Labeo dyocheilus	20	Cryopreservation of milt	Long term conservation and breeding	Y
Labeo dero	20	Cryopreservation of milt	Long term conservation and breeding	Y
Tenualosa ilisha	20	Cryopreservation of milt	Long term conservation and breeding	Y
Ompok malabaricus	10	Cryopreservation of milt	Long term conservation and breeding	Y
Shizothorax richardsonii	10	Cryopreservation of milt	Long term conservation and breeding	Y

Wild food species conserved (scientific name)	Size of collection (number of accessions and quantities)	Conservation conditions	Objective(s)	Characterization and evaluation status
Tor putitora	50	Cryopreservation of milt	Long term conservation and breeding	Y
Tor khudree	20	Cryopreservation of milt	Long term conservation and breeding	Y
Clarias magur	20	Cryopreservation of milt	Long term conservation and breeding	Y
Heteropneustes fossilis	10	Cryopreservation of milt		Y

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37. **Are any *in situ* conservation and management activities or programmes established in your country that supports maintenance of wild food species? If so list these in Table 17 provide the following information for each activity or program: site name and location, production system(s) involved, conservation objective and specific actions that secure wild food species (if any).**

Table 17. *In situ* conservation or management activities or programmes for wild food species.

Wild food species conserved (scientific name)	Site name and location	Size and environment	Conservation objective(s)	Actions taken

Wild food species conserved (scientific name)	Site name and location	Size and environment	Conservation objective(s)	Actions taken
Citrus medica, Elaeocarpus, Haematocarpus, Garcinia, Grewia, Salacia, Ziziphus, Nephelium, Buchanania, Rubus, Syzygium, Coccinia, Baccaurea, Artocarpus, Musa, Dioscorea, Colocasia, Coix	Great Nicobar Biosphere Reserve, Andaman and Nicobar Islands	885 km2; represents tropical forest biome, and is located in tropical Indo-Malayan biotic zone	Biosphere Reserves roughly corresponding to IUCN Category V Protected Areas. It often includes one or more National Parks and/or Wildlife Sanctuaries -to serve as a wider base for conservation of entire range of living resources -to bring out representative ecosystems under conservation and sustainable use on long basis -to ensure participation of local people for effective management and advise on means of improving livelihood of local inhabitants through sustainable use - to integrate scientific research with traditional knowledge of conservation, education and training	• Stringent security • Not allowing for any collection /destruction • Inventorisation of biodiversity; frequent monitoring of changes in population • Protection for flora, fauna, and also human communities inhabited in these regions • Awareness generation to local people about importance of biodiversity
Dioscorea, Vigna, and Amaranthus , Dillenia indica, Maerua oblongifolia, Aglaia elaeagnoidea, Salvadora persica, Cordia gharaf, Aegle marmelos, Phyllanthus indofischeri, Pueraria tuberosa, Syzygium alternifolium, Cycas beddomei	Seshachalam Biosphere Reserve in Chittoor and Cuddapah districts of Andhra Pradesh	4,756 km2; located in Eastern Ghats in southern Andhra Pradesh; represents typical monsoon climate		

Wild food species conserved (scientific name)	Site name and location	Size and environment	Conservation objective(s)	Actions taken
Citrus medica, Coptis teeta, Dioscorea pentaphylla, D. wallichii, D. prazeri, D. wattii, Prunus spp., Rubus spp., Rhododendron spp., Castanopsis indica, Chenopodium album, Dioscorea bulbifera, Zanthoxylum rhetsa, Solanum kurzii, Eryngium foetidum, Centella asiatica, Colocasia esculenta, Canarium strictum, Dioscorea alata, Elaeocarpus aristatus, Dendrocalamus strictus, Clendrodendrum colebrookianum	Dihang-Dibang Biosphere Reserve, in Dibang Valley, Upper Siang, and West Siang districts	5,112 km2; lies at tri-junction of Oriental, Indo-Malayan and Palearctic components and represents East Himalayan biodiversity hotspot		
Cucumis hystrix, Curcuma amada, Dioscorea spp., Dillenia indica, Cordia dichotoma, Euryale ferox, Trapa, Dioscorea alata, D. bulbifera	Dibru-Saikhowa Biosphere Reserve in Tinsukhia and Dibrugarh districts of Assam	765 km2; located in southern bank of river Brahmaputra; enjoys tropical monsoon climate with hot and wet summer		
Artocarpus hirsutus, Schleichera oleosa, Grewia tiliifolia, Syzygium spp., Cinnamomum spp., Phyllanthus emblica, Garcinia morella, Garcinia gummi-gutta	Nilgiri Biosphere Reserve in states of Tamil Nadu, Kerala and Karnataka	5,520 km2; exemplifies tropical forest biome within Western Ghats system of mountains		
Citrus medica, Cucumis setosus, Panicum sumatrense, Paspalum scorbiculatum, Vigna umbellata, Dioscorea bulbifera, Dioscorea spp., Alangium salvifolium, Buchanania lanzan, Curcuma angustifolia, Centella asiatica, Aegle marmelos, Solanum nigrum	Pachmahri Biosphere Reserve, Hoshangabad district of Madhya Pradesh	4,982 km2; located in central Highlands of India, unique for its sal forests and tribal population, and with varied climatic conditions		
Citrus latipes, C. medica, Cucumis hystrix, Prunus jenkinsii, Vigna umbellata (wild form)	Nokrek Biosphere Reserve, West, East and South Garo Hills districts, Meghalaya	820 km2; falls in Burma monsoon forest biogeographic unit and forest approach the type 'Eastern Sub-montane Semi Evergreen Forests'		

Wild food species conserved (scientific name)	Site name and location	Size and environment	Conservation objective(s)	Actions taken
Solanum torvum, Dioscorea pentaphylla, D.bulbifera, D. puber, D. oppositifolia, , Ziziphus nummularia, Z. oenoplia, Centella asiatica, Cordia macleodii, Pueraria tuberosa	Similipal Biosphere Reserve, Mayurbhanj district, Odisha	5,569 km2; represents four biotic provinces –Eastern Plateau, Chhotanagpur, Lower Gangetic Plains and Coastline		
Cajanus lineatus, Garcinia imberti, Madhuca bourdillonii, Syzygium bourdillonii	Agasthyamala Biosphere Reserve in Tamil Nadu and Kerala	3,500 km2; falls in Indo-Malayan realm, and Western Ghats biogeographic zone; tropical monsoon climate		
Allium stracheyi	Nanda Devi Biosphere Reserve in Chamoli, Bageshwar and Pittoragarh districts of Uttarakhand	6,407 km2; falls in west-Himalayan Biogeographic province of zone Himalaya; some areas experience cold desert nature		
Zizyphus jujuba, Vigna trilobata, Borassus flabellifera	Gulf of Mannar Biosphere Reserve, Tamil Nadu	10,500 km2; located in southern –tip of India, falls within tropical dry or deciduous forest biomes and Coromandel biogeographic provinces		
Garcinia spp., Syzygium cumini, S. formosum, S. oblatum, Bauhinia purpurea, Ficus roxburghii, Dillenia indica, D. pentagyna, Spondias pinnata	Manas Biosphere Reserve in Kokrajhar, Chirang, Baksa, Udalguri,and Darrang districts of Assam	2,837 km2; located in Himalayan foothills on the north of river Brahmaputra, belongs to Tropical Humid Forest Biome.		
Nypa fruticans, Grewia, Ziziphus nummularia, Z. oenoplia	Sunderban Biosphere Reserve, 24-Parganas dist., West Bengal	9,630 km2; the largest mangrove forests in world.		

Wild food species conserved (scientific name)	Site name and location	Size and environment	Conservation objective(s)	Actions taken
Bergenia ciliata, Dioscorea bulbifera, Allium wallichii, Zanthoxylum spp., Rhododendron arboreum	Khangchendzonga Biosphere Reserve, West Sikkim, Sikkim	2,931 km2; located in eastern part of Hindukush Himalaya, lies in Sikkim Trans-Himalaya		
Madhuca indica, Buchanania lanzan, Emblica officinalis, Tamarindus indicus, Panicum sumatrense, Paspalum scorbiculatum, Vigna umbellata	Achanakmar Amarkantak Biosphere Reserve in Chhattisgarh and Madhya Pradesh	3,835 km2; spreads from Maikal hill ranges to the jurisdiction of Vindhyan and Satpura Hill ranges, in tropical dry or deciduous forest biome and Deccan peninsula biogeographic zone		
Atriplex spp., Capparis, Salvadora, Ziziphus nummularia, Citrullus colocynthis	Kachchh Biosphere Reserve, Kutch dist., Gujarat	12,454 km2; represents unique combination of saline deserts and seasonal wetlands		
Hippophae salicifolia, Hippophae rhamnoides subsp. turkestanica, Oxyris digyna, Sedum ewersii, Sedum tibeticum, Rheum tibeticum, Cicer microphyllum, Hippophae tibetana, Prunus mira	Cold Desert Biosphere Reserve, Lahaul & Spiti district of Himachal Pradesh	7,770 km2; it represents Trans-Himalayan biogeographic zone, with cold desert ecosystem		
Aegle marmelos, Centella asiatica, Maduca indica, Emblica officinalis	Panna Biosphere Reserve in Panna and Chhatarpur districts of Madhya Pradesh	2,999 km2; represents unique ecosystem within the narrow belt of tabletop mountains of 'Vindhyan Hill Ranges' and part of 'Bundelkhand region'		
Catla catla	Ganga River, Uttar Pradesh	10,000 River/Reservoir	To support self recruitment	Breeding and Ranching
Labeo rohita	Ganga River, Uttar Pradesh	10,000 River/Reservoir	To support self recruitment	Breeding and Ranching
Cirrhinus mrigala	Ganga River, Uttar Pradesh	10,000 River/Reservoir	To support self recruitment	Breeding and Ranching

Wild food species conserved (scientific name)	Site name and location	Size and environment	Conservation objective(s)	Actions taken
Labeo calbasu	Dudhwa sanctuary, Uttar Pradesh	5000 Tiger Reserve/ River	To support self recruitment	Breeding and Ranching
Labeo bata	Samaspur Bird Sanctuary, Uttar Pradesh	5000 Sanctuary/River	To support self recruitment	Breeding and Ranching
Labeo dyocheilus	Dudhwa sanctuary, Uttar Pradesh	5000 Tiger Reserve/ River	To support self recruitment	Breeding and Ranching
Tor khudree	Lonavala, Maharashtra	1000 Lake	To support self recruitment	Breeding and Ranching
Tor tor	Lonavala, Maharashtra	1000 Lake	To support self recruitment	Breeding and Ranching
Etroplus suratensis	Vembanad Lake, Kerala	5000 Lake	To support self recruitment	Breeding and Ranching
Horabagrus brachysoma	Vembanad Lake, Kerala	25,000 Lake	To support self recruitment	Breeding and Ranching
Labeo dussumieri	Vembanad Lake, Kerala	25,000 Lake	To support self recruitment	Breeding and Ranching
Macrobrachium rosenbergii	Vembanad Lake, Kerala	5000 Lake	To support self recruitment	Breeding and Ranching

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38. What activities are undertaken in your country to maintain traditional knowledge of wild food species (indicate if the extent to which these have already been described in sector reports)? How can traditional knowledge of wild food species be accessed and used to inform conservation and use decisions?

Vast traditional knowledge on Indian plant species documented in ancient and old textbooks has been properly data based in Traditional Knowledge Digital Library (TKDL), a major initiative by Council of Scientific & Industrial Research (CSIR) and Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homeopathy (AYUSH), Govt. of India. In addition, ICAR, New Delhi has published five documents on 'Inventory of Indigenous Technical Knowledge in Agriculture' (in CD form), which includes the knowledge on wild food species as well. During the implementation of National Agricultural Technology Project on Plant Biodiversity (1999-2005), ICAR-NBPGR along with other collaborating institutes documented vast first-hand information on wild edible plant species occurring in India. Validation of this documented information through biochemical means has been taken up by a few institutes within the country. All these initiatives will aid in prioritizing some species and developing strategies for their conservation and use.

Directorate of Mushroom Research, Solan is preserving wild mushrooms species collected from different parts of the country.

National Bureau of Fish Genetic Resources, Lucknow in collaboration with other institutions have documented various indigenous knowledge systems related to fisheries and their conservation. Traditional knowledge of fisher folks have been documented in major aquatic ecosystems across the country by different institutions. Several traditional and religious practices are being used by tribal and other local communities which help in conservation of resources.

39. Provide any available information on gender dimensions with respect to the maintenance of and knowledge about wild food species. These may include differences in the roles and insights of women and men with respect to harvesting particular resources, monitoring their state, overseeing their ecosystem management.

Wild food plants play a very important role in the livelihoods of rural communities as an integral part of the subsistence strategy of people in India. In many parts of the India, wild plants are obtained from forests or wild areas designated for extractive resources and managed by local communities. The Jeypore tract of Orissa, India, is a particular case in point. The Jeypore tract, administratively known as the Undivided Koraput district, is situated in the southern part of Orissa, India. Indigenous knowledge on wild tubers is an integral part of the traditional and sociocultural lives of people in India. Men and women, both young and old, have profound knowledge about the wild tuber species, but women have more practical knowledge of them.

They can identify a tuber species by looking at the leaf sheath colour and for the presence or absence of thorns. They decide on the best time for collecting tubers based on leaf characteristics: they collect tubers either before the leaves are formed or after the leaves become dry. According to the women, the tubers do not boil properly after leaves have grown. Women take the lead in the identification, collection, transportation, processing and marketing of all the tuber species. Women look after the entire process of food preparation, including washing, peeling, cutting, cooking and distributing tubers among the family members. Women play a central role in the conservation, management, and use of biodiversity.

Role and perception of women towards fisheries resources have been documented in various aquatic production systems. Access of women to aquatic resources and their contributions in resource management have also been documented. Efforts have also been made to increase awareness of women fisher folk towards sustainable utilization of fisheries resources.

Natural or human-made disasters and biodiversity for food and agriculture

This section collects information on natural or human-made disasters and their impact on and response from biodiversity for food and agriculture as a whole.

40. **Has your country experienced any natural or human-made disaster(s) that has had a significant effect on biodiversity for food and agriculture and/or on ecosystem services in the past 10 years? List in Table 18 those for which any information exists on their effect on biodiversity for food and agriculture and/or ecosystem services. Indicate the effect on different components or services as significant increase (2), increase (1), no change (0), some loss (-1), significant loss (-2), or not known (NK).**

Table 18. Natural or human-made disasters that has had a significant effect on biodiversity for food and agriculture in the past 10 years in the country.

Disaster description	Production system(s) affected (code or name)	Effect on overall biodiversity for food and agriculture (2, 1, 0, -1, -2, NK)	Effect on ecosystem services (2, 1, 0, -1, -2, NK)
2004 Tsunami, Coastal areas of Tamil Nadu, Andhra Pradesh, Andaman Nicobar Islands and Pondicherry.	C1, C2,L3, L7, M3	2	2
Odisha floods (2011)	C1, C2	1	1
Uttarakhand floods (2013)	C3, C7, L3, L4, L7, L8, M3, M4	1	2
2014 Jammu and Kashmir Flood	C3, C7, L3, L7, M3	1	1
2015 Chennai floods	C1, C2	1	0
Sikkim Earthquake (2011)	C1, C2, L3, L7, M3	1	1
Cyclone Hud Hud, 2014	C1, C2, L2, L6, M2	1	1
Drought, 2009	C1, C2, L1, L2, L5, L6, M1,M2	2	1
Flood	Self recruiting capture fisheries - Tropics	-1	-1
Flood	Self recruiting capture fisheries - Sub-Tropics	-1	-1
Flood	Fed-Aquaculture - Tropics	-1	-1
Flood	Fed-Aquaculture - Sub-Tropics	-1	-1
Drought	Self recruiting capture fisheries - Tropics	-1	-1
Drought	Self recruiting capture fisheries - Sub-Tropics	-1	-1

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41. Briefly summarize any available information, including the year of the disaster, a description of the effects of the disaster on the different components of biodiversity for food and agriculture and/or on the effects on ecosystem services, and references to the supporting documentation.

Tsunami (2004): The climate in the coastal regions of India affected by the Indian Ocean tsunami is based on the tropical monsoon cycle. The terrain is mostly flat with few mountains. 54 percent of the land is arable. The tsunami damaged approximately 11,827 hectares of cropland through salinization. Agriculture was relatively important and the disaster will have an effect on the coastal economy.
Floods Odisha (2011): The flood causes submergence of crop plants restricting respiration and gaseous exchange thereby ceasing all growth processes leading to death and decay. Aerobic crops cannot resist standing water and submergence. Rice resists standing water due to supply of oxygen to root through aerial parts but cannot tolerate submergence for more than 7days. Deep water paddy can resist flood to the extent of 15 days when at rapid growth stages. But at early stage of growth, sudden rise of water level, speed and muddiness of water are the factors which makes most of the varieties susceptible to damage under submergence. Since rice is the main crop in rainy season, the extent of damage varies according to days of submergence depending on topography of the land (Odisha Review, Mishra et al, 2010). In addition to that crops are also damaged due to sand cast.
Jammu Kashmir floods (2014): Saffro is grown at Pampore in Pulwama district, 13 km from Srinagar, as well as in Budgam and Kishtwar districts, all of which are badly hit by the floods.
The crop is grown on small land holdings with an average size of 0.5 hectares by some 16,000 families in 226 villages.
Chennai floods 2015): More than 20,000 hectares of crops have been damaged in Cuddalore district. In Chidambaram and Kattumannarkovil, almost 12,000 hectares of crops have been affected. At least 300 livestock have been lost in Cuddalore. Farmers have been unable to pump water from their fields as a result of disruptions in the power supply. Fishing boats and nets have been damaged, affecting the livelihoods of fisherman
Earthquake: During Sikkim earthquake (2011) 7500 ha of agriculture land damaged

Floods in several parts of the country causes inundation of the water bodies and affects the habitat conditions and leads to production losses in different production systems.

42. **Provide any available evidence from your country that changes in biodiversity for food and agriculture caused by natural or human-made disasters have had an effect on livelihoods, food security and nutrition.**

The increase in severity of natural disasters and the aided damage is attributed to climate change. The human induced climate change has been caused by the cumulative emissions of greenhouse gases which is the culmination of increasing consumption of fossil fuels.

Paddy is the main field crop grown during Kharif in these Islands. After the Tsunami disaster during December 2004 about 1375 ha. of paddy area is submerged further restricting the area available under paddy and other field crops. So emphasis is on crop improvement through selection of varieties, increasing crop intensity in the existing area

Uttarakhand floods (2013): Kabulpuri, Rai Ghati and Rampur Ghati villages in Lakshar tehsil of Haridwar district have been worst affected by floods in recent years. Summer crops have been washed out and the farms are in no shape to yield a winter harvest in 2013; the sowing season for rice, which coincides with the height of the monsoon (June to September) has been delayed as a result of heavy inundation of paddy fields caused by downpours and landslides.Though agricultural fields are routinely inundated with the clay that runs down surrounding mountains during summer glacial melts and the annual monsoon, this latest calamity has created a disaster zone in Uttarakhand. Besides the crops, the flood has also affected agricultural land and large chunks of land have been washed away.Uttarakhand flash flood (2013) has made most significant adverse impact in biodiversity for food and agriculture, at local level. As per official information by Uttarakhand principal secretary (agriculture), about 18,228 cattle were killed and 20,000 hectares of agricultural land was severely damaged in Rudrapryag, Chamoli and Uttarkashi districts.

India's marine fish catch has dropped by 5.3% in 2015 with oil sardines recording the sharpest fall of 51%. The reasons attributed include rise in water temperature, the El nino effect and over-exploitation. The decline in sardine catch will affect the livelihood security of the fishermen community.

43. **Provide any available evidence that the enhanced use of biodiversity for food and agriculture has contributed to improving livelihoods, food security and nutrition in the context of a natural or human-made disasters. Describe and provide source of information.**

Some farmers' practices are traditional, while others have evolved over a period of time, generally in response to local agro-

climatic changes. However, adaptive practices have largely remained confined to the respective local areas, and have not been documented for wider dissemination, use and benefit. In response to this, efforts were made by a consortium of 20 NGOs in eastern Uttar Pradesh to compile agricultural knowledge and practices which have helped communities develop their adaptive capacities in response to floods. Forty practices were video documented for the benefit of illiterate farmers. The target users are farmers and facilitators (be they government, NGO, or from academic institutions) who are working directly with farmers.
a. Intensification: Though the floods cause a dramatic effect, people are still able to recover some harvest or income because of crop intensification and related activities. For example, people grow hemp and vegetables like okra with sugar cane. Farmers also have established grain and seed banks, and engage in vegetable growing, fish culture, fodder production, or livestock rearing.
b. Diversification: The flood-affected region is richly biodiverse. People adapt with the help of a diversity of crop varieties, trees, plants, grass and animals besides the diversity in people's knowledge, skills, experiences and enterprises. The landless are able to make a living from small animals. When silt and sand spreads over paddy fields, people learn to grow watermelons, gourds and other vegetables and fruits.
c. Value addition: Local women's groups are engaged in processing activities to add value to paddy, milk, sugar cane or vegetables. The possibilities are immense, but due to lack of resources and information, the initiatives by farmers remain incompletely harnessed as yet.
d. Indigenous technical knowledge: Various adaptive practices in agriculture have a strong element of indigenous knowledge. Without any organised mechanism of developing and imparting technical know-how for people to survive in floods and other climate change induced situations, it is people's knowledge which has helped them to adapt and survive.
f. Crop cycle management. To cope with the flooding, farmers have adapted the crop cycle so as to reduce crop losses. The main strategies are: pre-flood cultivation (so farmers can harvest before the floods); cropping with floods (crops which grow well even in floods); and post-flood cultivation (planting late varieties or those which withstand water logging).

Invasive alien species and biodiversity for food and agriculture

44. **Are there invasive alien species identified in your country that have had a significant effect on biodiversity for food and agriculture in the past 10 years? List in Table 19 those for which any information exists on their effect on biodiversity for food and agriculture and/or ecosystem services. Indicate the effect on different components or services as strong increase (2), increase (1), no effect (0), some loss (-1), significant loss (-2), or not known (NK).**

Table 19. Invasive alien species that have had a significant effect on biodiversity for food and agriculture in the past 10 years.

Invasive alien species (scientific name)	Production system(s) affected (code or name)	Effect on components of biodiversity for food and agriculture (2,1,0,-1,-2, NK)	Effect on ecosystem services (2,1,0,-1,-2, NK)
Bird Flu virus	01	Avian species	Pest and disease regulation

Invasive alien species (scientific name)	Production system(s) affected (code or name)	Effect on components of biodiversity for food and agriculture (2,1,0,-1,-2, NK)	Effect on ecosystem services (2,1,0,-1,-2, NK)
Apple woolly aphid - Eriosoma lanigerum in 1909 Cottony cushion scale - Icerya purchasi in 1927 Subabul psyllid - Heteropsylla cubana in 1988 Coffee berry borer - Hypothenemus hampei in 1990 Serpentine leaf miner - Liriomyza trifolii in 1990 Spiralling whitefly - Aleurodicus dispersus in 1993 Sapota seed borer - Trymalitis margarias in 2001 Eucalyptus gall wasp - Leptocybe invasa in 2004 Erythrina gall wasp- Quadrastichus erythrinae in 2005 Solenposis mealybug Phenacoccus solenopsis in 2007 Papaya mealybug - Paracoccus marginatus in 2008 Madeira mealybug- Phenacoccus madeirensis in 2012 Jackbeardsley mealybug Pseudococcus jackbeardsleyi in 2012 Tuta absoluta- tomato pin worm or leaf miner. 2015 Western flower thrips, Frankliniella occidentalis 2015	F1, F2, C1, C2, C3	2	2
Oreochromis mossambicus	Self-recruiting capture fisheries - Tropics	-1	0
Clarias gariepinus	Self-recruiting capture fisheries - Tropics	0	0
Cyprinus carpio	Self-recruiting capture fisheries - Tropics	0	0
Water Hyacinth (Eichhornia crassipes)	C1, C2, C3	-2	-2
Crofton Weed (Ageratina adenophora)	C1, C2, C3	-1	-1
Water Fern (Salvinia molesta)	C1, C2, C3	-1	-1
Canary Grass (Phalaris minor)	C1, C2, C3	-1	-1
Siam Weed (Chromolaena odorata)	C1, C2, C3	-2	-2
Lantana (Lantana camara)	C1, C2, C3	-2	-2
Mikania (Mikania micrantha)	C1, C2, C3	-2	-2
Congress Grass (Parthenium hysterophorus)	C1, C2, C3	-2	-2
Mesquite (Prosopis juliflora)	C1, C2, C3	-1	-1

Invasive alien species (scientific name)	Production system(s) affected (code or name)	Effect on components of biodiversity for food and agriculture (2,1,0,-1,-2, NK)	Effect on ecosystem services (2,1,0,-1,-2, NK)
Prickly Pear (Opuntia spp.)	C1, C2, C3	NK	NK
Coffee Berry Borer (Hypothenemus hampei)	C1, C2, C3	-2	-2
Woolly Aphid (Eriosoma lanigerum)	C1, C2, C3	-1	-1
White Fly (Bemisia tabaci) biotype "B"	C1, C2, C3	-2	-2
Spiraling Whitefly (Aleurodicus dispersus)	C1, C2, C3	-1	-1
American Serpentine Leafminer (Liriomyza trifoli)	C1, C2, C3	-1	-1
Leucaena Psyllid (Heteropsylla cubana)	C1, C2, C3	NK	NK
San Jose Scale (Diaspidiotus perniciosus)	C1, C2, C3	-1	-1
Potato Tuber Moth (Phthorimaea operculella)	C1, C2, C3	-1	-1
Cottony Cushion Scale (Icerya purchasi)	C1, C2, C3	-1	-1
Late Blight of Potato (Phytophthora infestans)	C1, C2, C3	-1	-1
Bunchy Top of Banana (Banana bunchy top nanovirus)	C1, C2, C3	-2	-2
Downy Mildew of Grapevines (Plasmopora viticola)	C1, C2, C3	NK	NK
Wart Disease of Potato (Synchytrium endobioticum)	C1, C2, C3	-1	-1
Flag Smut of Wheat (Urocystis tritici)	C1, C2, C3	NK	NK
Coffee Rust (Heimelia vastatrix)	C1, C2, C3	-1	-1
Bacterial Blight of Paddy (Xanthomonas oryzae pv. oryzae)	C1, C2, C3	-1	-1
Golden Nematode of Potato (Globodera rostochiensis	C1, C2, C3	-1	-1

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45. Briefly summarize any available information related to the invasive alien species listed in Table 19, including a description of the effects of the invasive alien species on the different components of biodiversity for food and agriculture and/or on the effects on ecosystem services, and references to the supporting documentation.

Plants
INVASIVE ALIEN WEEDS
Many alien terrestrial and aquatic weeds have entered into India accidentally. These weeds cause enormous direct or indirect losses to ecosystems and threaten biodiversity and water availability. Some of the most important noxious weeds of alien origin in India are Salvinia molesta D. Mitch., Eichhornia crassipes (C. Martius) Solms-Laub. and Alternanthera philoxeroides (C. Maritus) Griseb. among aquatic weeds, and Opuntia spp., Lantana camara L., Ageratina adenophora (Sprengel) K. and R., Chromolaena odorata (L.) K. and R., Parthenium hysterophorus L., Acacia melanoxylon R. Brown, Mikaniamicrantha H.B.K. and Prosopis juliflora (Sw.) DC. among terrestrial weeds. Most of these weeds have occupied such niches where chemical or mechanical control measures are neither feasible nor economical. They include forest areas, tea, rubber and other plantation

crops, vacant or grazing areas and water bodies.
The distribution of selected exotic weeds viz. Lantana camara, Chromolaena odorata, Mimosa pudica, Eupatorium repandum and Opuntia dillenii in different vegetation types, viz., moist deciduous forest, dry deciduous forest, scrub jungle, mixed deciduous forests, evergreen forests, teak, eucalypt, wattle and coffee plantations of Nilgiri Biosphere Reserve (NBR) in the Western Ghats were studied (Mahajan and Azeez, 2001). The following areas in NBR namely, i) Mudumalai Wildlife Sanctuary, ii) Silent Valley National Park, iii) Upper Bhavani (Upper Nilgiris) and iv) Siruvani forests were selected.
Classical biological control involving introduction of host specific organism from their country of origin offers highly effective and eco-friendly solutions to the problem of invading alien weeds. However, proper planning in the introduction of host-specific exotic bioagents to combat the invasive alien weeds is essential. Once successful, the natural vegetation returns to the site and all other associated problems are solved. The maximum degree of success in classical biological control has been achieved in aquatic weeds (55.5%) followed by terrestrial weeds (23.8%)

Livestock
There is no invasive alien species regarding AnGR which has influenced the biodiversity for food and agriculture. However, in recent time first reports of bird flu caused by influenza virus in poultry in India came from Nandurbar district of Maharashtra on 19 February 2006. After, first epidemic, there has been few more stances when the disease reported in different parts of the country. Although, it does not seem to affect the biodiversity for food and agriculture, as a part or whole.

Insects

Apple wooly aphid:Erisoma lanigerum got introduced from U.K. in 1909. The predators Coccinella. septempunctata,Hippodamia variegata , Eupeodes confrater and Brinckochrysa scelestes were able to feed the aphid colonies. The aphelinid parasitoid Aphelinus mali was introduced from U.K. into India in 1930. It proved effective in Himachal Pradesh, Kashmir valley and later in Nilgiris, Kodaikanal and Shillong.
In recent years, the parasitism by A. mali declined due to indiscriminate use of insecticides. Re-colonization of A. mali @ 1000 adults or mummies/infested tree once as soon as infestation is noticed has been found promising against this pest
Cottony cussion scale Icerya purchasi (Hemiptera: Margarodidae) is apparently native to Australia. The scale appeared in epidemic form in the Nilgris Hills in 1927 infesting many crops including citrus. It was brought under the control by the introduced ladybird beetle Rodalia cardinalis (Ori. Australia) was Introduced in 1926 via USA released in 1930.The fascinating success of this scale control has established biological control as valid method of pest control
Codling moth:Cydia pomonella is native to Europe. It attacks apple, pears, walnut, and other fruit trees. It is confined to Leh and Kargil area of J.&K. Weekly releases of Trichogramma embryophagum and T. cacoeciae pallidum @ 2000 adults per tree (first release to be made when the first moth is caught in pheromone trap) usually in June- July reduces the damage (Singh, 2000).
Subabul psyllid: A significant pest of Leucaena leucocephala grown extensively in community forestry and agro-forestry ecosystems for fodder. It is known to cause defoliation, wilting, dieback, and in some cases, plant death.
It is native to Central and South America. It was noticed in Chengalpat district in 1988 (Gopalan et al. 1988) and Bangalore during May 1988 in Karnataka and later AP, Kerala. A number of native general predators such as Cheilomenes sexmaculata and Pantala flavescens were found feeding when there was outbreak of the psyllid, but they did not exercise the required control.In 1988, the coccinellid Curinus coeruleus was introduced from Mexico and the predator has since successfully established in Karnataka, Maharashtra, A.P. and Tamil Nadu now providing control of the psyllid. Coffee berry borer: Adult beetle makes an entrance hole in the ripe berries and lays bean shaped eggs. The larva feeds on the coffee seed. Native of northeast Africa. Reported in Gudalur in the Nilgiris in 1990-Introduced probably from Sri Lanka. It has now spread into many coffee growing areas of Tamil Nadu (Gudalur and Kilkotagiri), Kerala (Wyanad) and Karnataka (Kodagu). The incidence varies from 2-95% . Cephalonomia stephanoderis, Prorops nasuta and Phymastichus coffea introduced from Mexico and Columbia between 1995 and 1999.
Papaya mealybug: Paracoccus marginatus is native to Mexico. -First reported in India from Coimbatore in July 2008 infesting papaya plants, and since then it has spread in many of the neighbouring states.-It is invasive on 60 different species of plants of agricultural and horticultural importance. Papaya, tapioca, mulberry were worst affected. Three parasitoids, Acerophagus papayae, Pseudleptomastics Mexicana and Anagyrus loecki were imported in India in July 15th 2010 from Puerto Rico under USDA APHIS facilities. Have provided substantial success of the pest.
Eucalyptus gall wasp apparently originated from Australia, is a pest in several countries Its occurrence was recorded in 2004 in Tamil Nadu, which was subsequently found in several locations in Tamil Nadu, Karnataka, Andhra Pradesh and Uttar Pradesh in 2007. Seedlings in nurseries and 6-8 month old saplings are highly susceptible to this pest. Gall formation by L.invasa damages growing shoot tips and leaves of Eucalyptus resulting in quicker abscission of leaves and drying of shoots. Heavy galling prevents further growth of the infested shoots. Several indigenous parasitoids such as, Aprostocetus sp., Megastigmus viggiani Viggiani, Parallelaptera sp., and Telenomus sp. were found parasitizing L. invasa. Among them, M. viggiani was dominant causing about 30 % parasitism. Quardrastichus mendeli was obtained from Israel on 19th November 2008. The exotic parasitoid was released Karnataka, Andhra Pradesh, Tamil Nadu, Punjab, Gujarat, Orissa, and Uttaranchal in 2011. Quardrastichus mendeli has established in all the areas in which parasitoid was released. Both M. viggiani and Q. mendeli supplement each other in causing heavy parasitism on the gall wasp. Megastigmus viggiani selects host lava with the older pink/brown galls, while Quardrastichus mendeli prefers young larva with green galls.The parasitism went up to 90% in the eucalyptus plantations in different locations in India.

Phenacoccus madeirensis is of Neotropical origin ;P. madeirensis was first collected on Cestrum nocturnam in 2012 in Karnataka followed by Cotton, Cestrum diurnm, Hibiscus rosa-sinensis, Lantana camera, Clerodendron viscosum, brinjal, potato, acalypha, crossandra, tapioca and mulberry were recorded as host plants for Madeira mealybug in parts of Karnataka, and Tamil Nadu. The cotton crop was severely damaged by the mealybug, and the incidence went up to 100% of the cotton plants cultivated in area of 7.2 hectares. Four parasitoids namely Allotropa sp., Anagyrus sp nr. sinope, Anagyrus quadrii and Anagyrus loecki were recorded on P.madeirensis Among them, A. quadrii was predominant. Anagyrus amnestos was also found to be potential parasitoid of Madeira mealybug. Besides the above parasitoids, Cacoxenus persipicax, Cryptolaemus montrouzieri, Scymnus sp. and cecidimyiid Diadiplosis were found feeding on the Madeira mealybug in India . They are capable of keeping the pest under check

Aquaculture

Government of India legally introduced tilapia, Oreochromis mossambicus and common carp, Cyrpinus carpio for improving fish production from open natural water bodies. Later both fishes became invasive and established in almost all inland natural bodies, affecting native fishes and ecological changes. However, production of tilapia increased from reserviors which is contributing as food for human consumption. Though production of tilapia is high, the cost of the fish is less, and fishermen get less money and affects their livelihood. Both these fishes affect, the breeding ground of other fishes and reduce the production of other economically important fishes. Later farmers introduced African catfish, Clarias gariepinus, illegaly, in culture ponds, which is also causing deleterious effects in the culture ponds as well as in the natural water body. It estblished in certain natural water bodies and almost displaced the native fishes in that ecosystem. Since the fish is economically not profitable, it effect the livelihood of the fisherfolk.

46. Has biodiversity for food and agriculture contributed to managing the spread and proliferation or controlling established invasive alien species in your country? If yes, provide information on the invasive alien species involved, the components of biodiversity for food and agriculture and any indication on how the components of biodiversity contributed to managing the spread and proliferation or controlling established invasive alien species in your country. Provide references to the supporting documentation.

Plants
Invasive species have serious economic and environmental implications across a range of ecosystems especially agro-ecosystems.Several countries have suffered enormous losses due to the inadvertent introduction of invasive alien species of pests along with transboundary movement of planting material of crops. Several pests were introduced on various crops in India too which have since become serious pests and continue to cause damage year after year. A few have been listed below:
• The fluted scale (Icerya purchasi), a serious pest of citrus and native of Australia was introduced into India before 1928 from Sri Lanka probably on wattles (Acacia sp.) to later become a serious pest on citrus in south India. A large-scale campaign was organized in south India from 1946 to 1950 to check the spread of this pest.
• The occurrence of the spiraling whitefly, Aleyrodicus disperses, is an example of an exotic insect invading native crops. It is a native of Central America and spread westward across the Pacific, Southeast Asia and entered India through Sri Lanka in 1994. This insect has been reported as feeding on more than 150 species including fruit plants, vegetables and avenue trees. In India, this insect is also reported to feed on the leaves of intensively managed teak plantations.
• Heavy losses in grain yield of Cicer arietinum crop in states of Haryana, Madhya Pradesh, Punjab and adjoining areas occurred during 1981-82 due to the introduction of virulent biotype of Aschochyta blight from the Middle East.
• Bunchy top of banana caused by Banana bunchy top virus entered India from Sri Lanka and causes loss to banana of over Rs 4 Crores annually.
• The dreaded Golden nematode (Heterodera rostochiensis) introduced from UK along with exotic seed in 1960s has been causing severe infestation of potato in the Nilgiris.
• Lantana camara is a terrestrial weed of South and Central American origin introduced as an ornamental plant in 1809 to India. Usually this weed invades disturbed natural ecosystems and adversely affects biodiversity. The weed is distributed throughout India. It causes serious losses to ecosystems and habitats.
• Mikania micrantha has been a serious problem in the southern states and also in the northeastern states. This perennial climber has been known since 1918 and has been reported as a menace in many parts of Asia and Oceania. Many forests and agricultural crops are being suppressed owing to the prolific spread of Mikania. Numerous field crops (sugarcane, maize, rice, pineapple, cotton, coffee), forestry crops (teak, eucalypts) and agroforestry systems are under the grip of this invasive weed.
• Chromolaena odorata is a serious problem in pastures, forests, orchards and commercial plantations in South and Northeast India. It is widespread in coconut, rubber, oil palm, tea, teak, coffee and cardamom plantations and also in natural forests.
• Aquatic weeds likeSalvinia molesta Mitchell (Family: Salviniaceae) and Eichornia crassipes (Martius) (Family: Pontederiaceae) are problematical for farmers in many places and are of serious concern among paddy cultivators in the state of Kerala. Salvinia made its entry in India before 1900 and by now more than 0.2 million hectares of waterbodies are affected. In addition to the problems caused to the farming community, the weed can choke waterbodies and serve as ideal breeding grounds for mosquitoes. Eichornia, popularly known as water hyacinth, was introduced as an ornamental pond plant from the Amazon Basin; now it has become a menace in the backwaters.

All these examples clearly demonstrate how introduction and establishment of alien invasive pests into new areas may severely damage the crop production and agro-economy of a nation.

The social impact of many IAS is still not known. This is a big issue for India as the future actions are likely to be based on the socio-economic data. It is only recently that V. Arivudai Nambi of M.S. Swaminathan Research Foundation, Chennai has investigated the possible social impacts of a few important invasive weeds in Southern India with reference to impact on natural ecosystems and on human shaped ecosystems, agroecosystems and wastelands (Nambi, 2001). The findings are enumerated below:

IASand Roofing Materials

The Malaiyalis inhabiting the Tenmalai region of the Javadis Hills in northern Tamil Nadu are finding it expensive to procure thatch grass (Cymbopogon sp.) for roofing their huts. They have to trek longer distances, to lower altitudes, to harvest thatch grass. There are a larger number of tiled houses in the villages than in the past, the tribals attributing them to non-availability of thatch grass. This is so because tracts of savannah woodlands in the lower slopes of the Javadis are covered with thick undergrowth of Chromolaena sp. It would certainly be of interest to understand the relationship between the spread of Chromolaena sp and the non-availability of thatch grass.

It is also important to take note that there is a periodic seasonal migration to Coorg and Kerala in search of wage labour, whose role in number of tiled houses need to be understood.

IAS - Cattle Grazing and Livelihoods

Several old tribal farmers in Pudur Nadu in the Javadi Hills reported that their cattle face severe shortage of fodder due to the invasion of Lantana camara, which has occupied and over run wastelands and open forests. The problem is quoted as the chief reason for the failure of the Milk Producer's Co-operative at Pudur Nadu.

Field visits to the Kolli hills brought to light the possible impact of L. camara, on the livelihoods of the Malaiyalis. The species occupies vast areas as undergrowth covering the grazing and grass growing areas adjacent to reserve forests where the tribals used to collect thatch grass. Some former village grazing grounds have also been overrun with L. camara. Local grazers spoke about the loss of native grasses and the decline in the number of cattle. Exploratory studies on the causal relationships between cultivation of minor millets, animal traction for dryland cultivation, dung production for maintaining small millet productivity, would throw much light on some of the issues.

IAS and Agroecosystem Management Strategy: Lessons from Traditional Agriculture

The Working Plan of the Forest Department (1940) reports that there was a thick undergrowth of Lantana camara in the Inner Javadis occupying the enclosures in which sandalwood thrived. The tribals have co-adopted this alien species in their agricultural system. Lands that contain extremely poor soils, invariably found in steep slopes are periodically abandoned, which get colonized by L. camara. These bushes are cleared once in three or four years, burnt and ashes returned to the soil. These plots are cultivated once or twice and abandoned again for the next cycle.

Interstate Movement of IAS

One species of weed belonging to the Compositae family has invaded the wastelands in Wayanad were brought in through cowdung imported from parts of Karnataka. It may be mentioned that large quantities of dung are transported into Wyanad from Karnataka for agricultural purposes.

Goats and Sheep – Pathways for Invasive Alien Prosopis juliflora Expansion in Commons and Fallows

Prosopis juliflora has colonized the saline coastal tracts as well as abandoned agricultural lands of northern Tamil Nadu. Large areas around Pulicat Lake and the stretch between Chennai and Vellore are covered with a thick canopy of the plant. The species, has become invasive because of goat grazing. Prosopis pods are highly nutritious containing a high amount of protein and are fed regularly to goats and to a lesser extent sheep. Such feedings are more pronounced in the summer months of April, May and June, when there is a shortage of fodder and feed. Goats graze in agricultural fallows and drop their excreta, leading to the spread of the species over fallow agricultural lands. Studies on the link between spread of P. juliflora and goats would be a valuable contribution to its management.

Tenure may also favour or disfavour the spread of IAS of plants. For example, P. juliflora has spread in agricultural lands abandoned specifically for housing. This is so because, existing legal restrictions do not permit the conversion of agricultural lands as housing sites unless not in use for at least three years.

The financial cost of reclaiming agricultural lands covered with P. juliflora would indeed be prohibitive. The cost is variable largely depending on the age of establishment of the plants. Older the plant, more the expense but larger the financial return. Removal of branches alone does not really help, as it leads to regeneration from rootstock and restablishment. Removal of root stock consumes time, energy and efforts.

IAS and Natural Resource Conflicts

An interesting case of the implications for management of IAS becomes known from the following piece of data collected from Sethiyathope, near Chidambaram. There is a conflict of interest between fishermen and farmers due to the presence of IAS Ipomoea. The fishermen prefer having Ipomoea in water courses, since the plants offer protection to fingerlings. The farmers complained that the alien species was a menace as it obstructed water flow and caused increased siltation of watercourses. Flow of water for irrigation was extremely crucial as it decides the tilling, ploughing and transplantation schedules.

IAS Management: Gender Implications

IAS of plants may have differential gender impacts on rural society. While they may be a boon to one gender, but have negative impacts for the other. A few examples of such gender impacts of some invasive alien weeds as a pointer to incorporate gender dimensions in their management is illustrated.

Prosopis juliflora is an introduced alien species that is turning invasive. The species is fulfilling the fuelwood needs of millions of households in the country. In the light of massive loss of forests and their potential to colonise waste and fallow agricultural

lands, they are indeed a boon to the women of the country. On the other hand the species has become invasive on fallow rainfed and irrigated agricultural lands. Reclamation of such lands either for housing or for agriculture seem to favour men.
Only males are involved in removal of above ground biomass of the plant and are paid Rs 50/ day (with food) or Rs. 60/ day (without food). Women may be employed, but used only for removing the cut branches. If the roots of the plant are to be dug out, men are paid Rs 80/ day (with food) or Rs. 100/ day (without food), as it requires the use of crowbar and choppers. Females are not employed in the latter operations.
Women are generally not employed in the removal and firing of Lantana camara from fallow agricultural lands in the Javadi hills, Thiruvannamalai and Vellore Districts.
Female labour is employed in the removal of Parthenium hysterophorus. The plant is known for inducing allergies in humans and if more women are employed in their removal, its potential impacts require attention.

Aquaculture
Since India's fish production is depending on diversity of fishes available within the country, not any of the invasive species established in the country. Majority of the fishes cultured in farming system are Indian major carps and other native fishes. Though later some exotic fishes like, Malaysian catfish, Pangasianodon hypophthalmus introduced in aquaculture it did not become invasive. The fishes like tilapia, Oreochromis mossambicus, common carp, Cyrpinus carpio, and African catfish Clarias gariepinus got established in the system but in overall production it is not much.

Similarities, differences and interactions

47. Comment on those aspects with respect to the state, trends and conservation of associated biodiversity or wild food biodiversity in relation to the state, trends and conservation of sector genetic resources. It would be helpful to provide your observations under the following headings:

a. main similarities between associated biodiversity, wild food diversity and the different sectors;
b. major differences between associated biodiversity, wild food diversity and the different sectors;
c. synergies or trade-offs between associated biodiversity, wild food diversity and the different sectors.

The responses should include relevant information on socio-economic, political and cultural dimensions as well as biological ones. Information on the significance of common characteristics, differences, synergies and trade-offs with respect to achieving food security and nutrition, sustainable production or the provision of ecosystem services should also be provided.

Major genetic resources in the fisheries sector are still depend on the wild populations. Hence, generation of knowledge on wild genetic stocks of fish species of cultivable and conservation value is a major priority for the sector. This is in contrast to the scenario in domesticated animals and plants where breeds/varieties etc. are well documented. Hence, bridging this knowledge disparity between fisheries and other agriculture sectors is necessary for formulating common guidelines on issues related to biodiversity, IPR protection and technological advancements. Several initiatives have been undertaken toward this goal. A National Board for Management of Agrobiodiversity has been formed by the Govt. of India to coordinate and guide policies, guidelines and programmes for synergies in management of agro-biodiversity in various sectors related to food and agriculture. Two national level integrated programmes have been undertaken with a clear purpose of studying and utlising agro-biodiversity in major food sectors for sustainable livelihood enhancement and conservation:
1. Harmonising biodiversity conservation and agricultural intensification through integration of plants, animal and fish genetic resources for livelihood security in fragile ecosystems.
2. ICAR-CRP on Agro-biodiversity: National Network on Agro-biodiversity management.

Gaps and priorities

48. With respect to the state, trends and conservation of associated biodiversity and ecosystem services:

a. What are the major gaps in information and knowledge?
b. What are the main capacity or resources limitations?
c. What are the main policy and institutional constraints?
d. What actions are required and what would be the priorities?

a) Major gaps in information and knowledge

• Inadequate awareness and education
• Inadequate information
• Taxonomic constraint: Identity of the diversity of pollinators, detritivorous insects to be determined.
• Natural enemy (pollinators and predators) diversity to be fully worked out.

• Pollinator – plant relationships to be studied.
• Quantification of pollinator / detritivore efficiency.
• Production of pollinators / detritivores for utilization in glasshouses / agricultural systems

b) Capacity or resources limitations

• Inadequate education and research system
• Inadequate infrastructure and awareness programmes
• Shortage of trained insect taxonomists and no allocation of funds for training taxonomists

c) Policy and institutional constraints

• Needs repository of strains/pathogens/rumen microflora
• Less adoption of policies
• No agency to monitor and enforce standards.
• Policy to reduce / eliminate pesticide use to enhance / encourage pollinator activity

d) Action required and priorities

• Increased awareness programme
• More research and infrastructure
• Better policy implementation
• Allocation of funds for training taxonomists and positions for taxonomists in educational and research institutions
• Cataloguing of the pollinator and detritivore diversity in different regions of the country.
• Studies on
a. taxonomy of pollinators, detritivores, food insects
b. extent of pollination by different species of pollinators on different crops / plants in the wild,
c. degradation efficiency by detritivores

Only 1-5 % microbes are culturable and rest 95% are unculturable and therefore entire biodiversity can not represented. Now, researchers are trying hard to culture some microorganisms so as to conserve this hidden diversity.

India is having more than 3000 species of fishes, crustaceans and moluscs which have food value. Out of these less than 400 species are being utilised for food. Though these species are utilised as food, replenishment of these resources will be a question until and unless breeding of these species studied and ranched in the environment for ensuring sustainability. Biology and ecological aspects of the many species, which are utilised for food, is not studied in detail.
Due to natural calamities and man-made activities, the natural resources are declining.
Though India already enacted Biological Diversity Act 2002, there is no proper planning for improving the fish diversities in their system.
Ecosystem wise fish diversity databases has to be created and ecology and biology to be studied in detail for the species available in the system.

49. With respect to the state, trends and conservation of wild resources used for food:

a. What are the major gaps in information and knowledge?
b. What are the main capacity or resources limitations?
c. What are the main policy and institutional constraints?
d. What actions are required and what would be the priorities?

a. Major gaps in information and knowledge

• The information on wild resources used for food is well documented at various institutions like CSIR, ICAR, ICMR and SAU's in organised sector but informal sector like tribals/ folklore information needs to be compiled to enrich the data inventories.

• Insects currently being harvested only opportunistically from the wild for food. No national inventory of insects being used by different groups of people for food.
• No systems to produce them sustainably on a large scale have been developed

b. Main capacity or resources limitations

• Efforts are needed to strengthen the documentation and awareness programmes for the use and availability of theses wild resources for food. Proper skill full management and marketing trends are needed to popularise these resources.
• No funding for studies on insects that can be used as food or for the establishment of units for the large scale production of food insects

c. Main policy and institutional constraints

• As such there are no policy issue regarding wild resources but at institutional level PGR Awareness Programmes at Grass Root Level regarding the potential and nutritional aspects of these plants is needed.
• No standards for producing or marketing insect foods
• Legal framework to be developed.
• No policy to increase consumer acceptance of insects as food

d. Actions are required and what would be the priorities

• Priorities for the collection, evaluation utilization and conservation should be emphasised in current scenario.
• Ecogeographic surveys for better management of in situ populations.
• Ethnically and floristically rich and geographically distinct areas should be de marketed as in situ conservation sites, this point needs to be taken on priority.
• Initiation of studies to determine the
a. nutritional value of insects currently being used by different communities as food
b. replacing conventional protein supplements with insects in animal feed
• Publicity for the use of insects as food

Only a fraction of microbes are know to be used as food and still are many to be investigated for food purpose.

Knowledge of aquatic species and communities is crucial for the management of ecosystems and habitats. Identification, cataloguing and prioritisation of species are important tasks in conservation. More unexplored aquatic regions all over the country needs to be surveyed to describe the germplasm resources in future. For a successful ranching programme, intended for stock enhancement, the genetic structure of the original wild population should be determined before any new fish is released to the waters using appropriate molecular markers. By ensuring that the stocked population is having the same allelle as the wild population, reintegration of stocked fish could be more successful. This is not always ensured and thus species are randomly ranched to the water bodies. This practice will not only be detrimental to the stock replenishment but also cause deviation in the original genetic structure.

50. With respect to the impact and response to natural or human-made disasters and biodiversity for food and agriculture:
   a. What are the major gaps in information and knowledge?
   b. What are the main capacity or resources limitations?
   c. What are the main policy and institutional constraints?
   d. What actions are required and what would be the priorities?

a) Major gaps in information and knowledge
• Inadequate awareness and education
• Lack of databases about the effect of disaster
• Lack of early warning system & impact assessment
b) Capacity or resources limitations
• Inadequate funds
• Insufficient resources/infrastructure for mitigation
• Inadequate credit and insurance support
• Lack of legal support
c) Policy and institutional constraints
• Slower response post disaster/unorganized response
• Inadequate credit and Insurance support
• Lack of legal support
d) Action required and priorities
• Assessing AnGR diversity after disaster
• Legal support system
• Awareness programmes
• Compensation and Insurance for the losses

• fodder and nutritional support by Government after disaster

Fragmentary and very meagre amount of work has been done on impact of natural or man -made disaster on microbial biodiversity.

Due to geographical diversity and large size of the country, adequate assessment of the impact of disasters on biodiversity for food and agriculture is lacking. Comprehensive impact assessment programmes are required in this field.

51. **With respect to the impact of invasive alien species on biodiversity for food and agriculture:**
    a. **What are the major gaps in information and knowledge?**
    b. **What are the main capacity or resources limitations?**
    c. **What are the main policy and institutional constraints?**
    d. **What actions are required and what would be the priorities?**

a) Major gaps in information and knowledge
• Delayed information
• Lower response
b) Capacity or resources limitations
• Insufficient sophisticated diagnostic labs for disease emergence
• Less research in diagnostics, pharmaceuticals and vaccine development
c) Policy and institutional constraints
• Porous boundaries
• Less effective export/import policy
d) Action required and priorities
• Increased and more stringent quarantine services
• Early warning system
• Faster responsiveness
• More awareness programme

Plants
IAS are a serious threat to biodiversity and food security in India. With international trade in agricultural commodities growing under the WTO Agreement on Agriculture, plant quarantine and phytosanitary measures assume added importance. Trade in agricultural commodities is likely to serve as a mode of transport for exotic pests and diseases among trading countries. The awareness of the importance of quarantine measures in India started in the early twentieth century when the Indian Government in 1906 ordered compulsory fumigation of imported cotton bales to prevent the introduction of the Mexican species, the cotton boll weevil (Anthonomus grandis).
The policy of using government authority to prevent entry of dangerous exotic pests is based on the principle that it is preferable to undergo some inconvenience in an effort to exclude pests than to accept the expense of controlling them. The quarantine law was enacted for the first time in India in 1914 as the Destructive Insects and Pests (DIP) Act. A gazette notification entitled Rules for Regulating the Import of Plants etc. into India was published in 1936. Over the years, the DIP Act has been revised and amended several times to meet the growing requirements of liberalized trade.
The Directorate of Plant Protection Quarantine and Storage (DPPQS) operate through a network of quarantine stations located in different parts of the country that act as entry and exit points. Also, after the enactment of the National Policy on Seed Development in 1988, and the WTO Agreements in 1995, import of agricultural commodities was allowed more freely. This led to the introduction of several new pests and diseases into the country. Thus, the Plant Quarantine (Regulation of Import into India) Order 2003 (henceforth referred to as PQ Order), came into existence.
So far, i.e. till June 2016, thirty eight amendments of the PQ Order 2003 have been notified to the WTO: revising quarantine pest lists; incorporation of ISPM No. 15 compliance; recognition of irradiation treatment; pest free areas and cold treatments for fruit flies to allow import of fresh fruits; and revising the lists of crops under Schedules VI and VII to include 692 and 292 crops and commodities, respectively.
In 2007, the National Commission on Farmers has recommended developing a National Agricultural Biosecurity System characterized by high professional, public, and political credibility through integration of plant, animal and fish management systems on biosecurity based on risk analysis and management. It has also recommended establishment of synergies in requirements of international agreements and national regulations across these sectors to avoid duplication of resources. In response, a Core Group was constituted by the Department of Agriculture and Cooperation in 2008 for formulating recommendations for establishment of an Integrated National Biosecurity System. The Core Group in its report submitted in 2009, recommended establishment of the National Agricultural Biosecurity System requiring a new legislation which is more relevant in the context of the present scenario. An Agricultural Biosecurity Bill was thus drafted and submitted in 2013 to provide for establishment of an Authority for prevention, control, eradication and management of pests and diseases of plants and

animals and unwanted organisms for ensuring agricultural biosecurity and to meet international obligations of India for facilitating imports and exports of plants, plant products, animals, animal products, aquatic organisms and regulation of agriculturally important microorganisms and for matters connected therewith or incidental thereto.

Need for Inter-sectoral Cooperation

In India, the Ministry of Environment, Forests and Climate Change (MoEFCC) is the nodal Ministry for matters relating to biodiversity, and deals and negotiates with the Convention of Biological Diversity (CBD). The Ministry of Commerce and Industry in cooperation with the Ministry of Agriculture and Farmer Welfare is the nodal ministry for implementation of the phytosanitary aspects of the SPS Agreement of the WTO, and deals with quarantine norms and standards to be set up at the national level as per international requirements for minimizing the risks associated with the transboundary movement of pests (weeds, insects, nematodes and pathogens) along with agricultural commodities.

The agencies that control the activities of the agricultural sector on IAS include various agricultural universities at the state level, state agricultural departments and the Central Agricultural Ministry with the Indian Council of Agricultural Research as the core centre. For the forestry sector there are state forest research institutes, state forest departments and the Ministry of Environment and Forests with the Indian Council of Forest Research and Education as the core centre. Coordination and cooperation between forestry and agriculture and also among other related sectors is not taking place at the required level.

The knowledge and expertise among the agriculture and forestry sectors have to be tapped and how to best integrate the skills of these two groups is crucial. Habitat degradation and loss of biodiversity are two major consequences of IAS. Networking among experts in the fields of agriculture and forestry, both at the state level and at the centres will be very crucial to manage the inception and impact of invasive species in agro-ecosystem.

The need for the Government of India to tackle this issue is indicated by the variety and number of meetings held on IAS and related topics in India in recent time to deliberate on the emerging issues that confront not only the scientific community but also other stakeholders.

Management Options

Management of invasive species has three broad approaches, exclusion of IAS from the area to be protected (e.g. by quarantine or physical barriers), eradication and control. Control in this context assumes that the invasive is established but can be managed at undamaging population levels. These options are influenced by the extent of the invasion, the nature of the ecosystem invaded and particularly by the type of the invader.

While it is possible to establish general principles and tools for invasive species management, practical management strategies differ greatly between the various organisms and these need to be developed on a case-to-case basis by identifying the best options, tools and integrated strategies for eradication or long term management. The officials dealing in IAS need to establish long term programmes, arrange funding, establish cooperation between government agencies (and often between governments where IAS are trans-border problems) and involve the public at large. The appropriate legal and regulatory frameworks must also be in place to drive this process. All of these factors play a role in management of invasive species at the national level (Khetarpal and Gupta, 2006a).

The 15 Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species that Threaten Ecosystems, Habitats or Species were adopted by CoP 6 of CBD in 2002. These serve as broad guidelines for management of IAS. Besides these,a comprehensive toolkit on prevention and management practices of IAS has been brought out by CABI on behalf of erstwhile Global Invasive Species Programme proposes three major management options, prevention, early detection and eradication, and control.

Prevention of introductions is the first and most cost-effective option. This lesson has been learned the hard way from several cases of highly destructive and costly invasive organisms such as Ascochyta blight of chickpea, late blight of potato, whitefly “biotype B”in India.

Exclusion methods based on pathways rather than on individual species provide a way to focus efforts on pathways along which pests are most likely to enter national boundaries and to intercept several potential invaders linked to a single pathway. Three major possibilities to prevent further invasions exist:

1) Interception based on regulations enforced with inspection and fees
2) Treatment of material suspected to be contaminated with non-indigenous species
3) Prohibition of particular commodities in accordance with international regulations

All this calls for stringent quarantine measures to be adopted. Deliberate introductions of non-indigenous species need to be subject to pest risk assessment/ invasiveness risk assessment. Based on the invasive/ non-invasive nature of the species within its geographic distribution and taking into account its adaptability/ suitability in the new ecosystem it would be possible to assess its potential invasiveness. The species posing no or negligible risk can be immediately cleared for import but those with moderate risk should be tested on a trial basis under controlled conditions to assess invasive potential. The cost and time involved in understanding such studies is fully justified and would be much less than any eradication/ control strategy adopted in case it becomes invasive. The import of high risk species should be strictly prohibited. Special care should be taken for import of biocontrol agents to verify and ensure its host specificity.

Early detection and eradication of a potential invasive species is often crucial in determining the possibility of eradication or at least of effectively containing a new colonizer. Early detection in the form of surveys may focus on a species of concern or on a specific site. Species-specific surveys are designed, adapted or developed for a specific situation, taking into consideration the ecology of the target species. Site-specific surveys are targeted to detect invaders in the vicinity of high-risk entry points or in high value biodiversity areas. In this regard, India needs to have specific programmes to detect invaders at an early stage.

Eradication is successful and cost-effective only in response to early detection of a non-indigenous species. However, a careful analysis of the costs and likelihood of success must be made, and adequate resources mobilized, before eradication is

attempted. Most eradication programmes need to employ several different methods. Each programme must evaluate its situation to find the best methods in that area under the given circumstances. Successful eradication programmes in the past have been based on 1) mechanical control, e.g. handpicking of snails, 2) chemical control, e.g. using pesticides or irradiation methods, and 3) habitat management, (e.g. grazing and prescribed burning). Island ecosystems are particularly amenable to eradication as the area is defined due to the presence of natural water barrier. The Sterile Insect Technique used in Japan and Mauritius for eradication of certain species of fruit flies, a serious pest of several fruits and vegetables, is a good example.
Control is the last step in the sequence of management options of an invasive species when eradication is not feasible. The aim of control is to reduce the density and abundance of an invasive organism to keep it below or at an acceptable threshold. There are several specific methods for controlling invasive species. Many of the control methods can also be used in eradication programmes.
• Mechanical control is highly specific to the target, but always very labour-intensive. In countries where human labour is costly, the use of manual methods is limited mainly to volunteer groups.
• Chemical control is often very effective as a short-term solution. The major drawbacks are the high costs, the adverse effects on non-target species, and the possibility of the pest species evolving into resistant strains and environmental pollution.
• Biological control in comparison with other methods, when successful, is highly cost effective, permanent, self-sustaining and ecologically safe because of the high specificity of the agents used. Biological control is particularly appropriate for use in nature reserves and other conserved areas because of its environmentally friendly nature and the increasing instances of prohibition of pesticide use in these areas.
• Integrated pest management (IPM), combining several approaches, will often provide the most effective and acceptable control.
In India, there has been an inertia among the stakeholders in tackling invasive species. The concerned ecosystems are very sensitive and hence, the control strategy to be adopted must be as safe as possible. Eradication is usually not feasible but strategies can be evolved to reduce the density and abundance of invasive below the threshold level. Chemicals do offer a short term management option, but as problems with synthetic pesticides became apparent, biocontrol is usually seen as an ecologically benign replacement technology for pest management. The main thrust is on biological control of weeds and insects. However, care should be taken when employing exotic pathogens/ parasites for biological control that they should undergo strict quarantine procedures at recognized national institutions before introduction as a control agent.
Some alien weeds have been naturalized in India and provide income for the rural community. One example is the Lantana basket weavers in some districts of Tamil Nadu, who have been in this business for more than 50 years. Thus there is also a need to address related socio-economic aspects.
Regional and national programmes are integrated to develop best management practice frameworks and systems-based actions for the most destructive invasive species. These are then designed around a ‘three- stage hierarchy’ approach for management: prevention, early detection/eradication and long-term control.
Prevention, early detection and eradication are recognised as the most efficient methods to stop the tide of a new invasive species and there is a need to build capacity in all agencies responsible for these activities. Under prevention, advice ‘Horizon scanning’ and which invasive species to prioritise for action based on risk assessments and eco-climatic modelling are provided. For early detection and eradication, well designed regional and national surveillance schemes are built such that the wide variety of invasive pathways of movement can be covered.
Long-term controlis needed for the most destructive and existing invasive present within countries. The actions need to be taken regionally and nationally given the nature of invasive and their wide geographical spread. The technologies of stand-alone biological control and integrated pest management (IPM) should be promoted because they are known to be able achieve wide geographical scale impacts, are highly cost effective and environmentally compatible. The nature of invasion of regional destructive species results in many species ‘losing’ their host-specific natural enemies. Biological control, through the introduction of screened and tested host-specific natural enemies re-establishes the balance; this technology has proven to be highly cost –effective. IPM, which is also cost effective, should be used for those invasive species that need a broader spectrum of management inputs, but still building on biological control.
The issue of biological invasions requires coordinated actions at global, regional, national and local levels; only in this way will negative impacts on rural livelihoods be removed. In developing a comprehensive and integrated invasive species management programme, there is a need to reduce the collective impact of the worst pests on crops, livestock, human health and livelihoods. These technologies need coordination and action at both regional and national levels. The most threatening regional and national invasive species needs to be identified and prioritised for action.In case of invasive plants,this action should be supportedusing the existing extension and outreach programmes that are amenable to biological control and IPM. The capacity of regional and national agricultural and environment research organisations in best management practices for biological invasions should also be strengthened against the most destructive invasive species.

Aquaculture
More than 20 exotic fish and shell fish species were introduced in India for increasing fish production, out of which very few became invasive in our waters. Lack of proper survey and mapping of the area where the invasive species established is the main impediment for controlling the species. The invasion biology is not studied for most of the species in our context.
Though there are strict policies are in place for introducing the exotic fish or shellfish to India and its culture, farmers bring introduce fish illegally and start culturing. Once the species escaped to the natural system then only authorities notice it start action for eradicate the species. Since the area is very large and the invasive fishes infested in large water bodies, eradication is very difficult. Proper awareness and education about these species among the people is also lacking.

Strict implementation of the policies regarding introduction of the exotic to be followed and fisherfolks need to be educated on deleterious effect of invasive/ exotic species.

CHAPTER 4: The state of use of biodiversity for food and agriculture

Proposed structure of the chapter and information to be included in the Country Reports

The questions in this chapter seek to obtain information on:

- The contribution of biodiversity for food and agriculture to:
  - production (or provisioning ecosystem services) and especially to food security and nutrition and to rural poverty reduction;
  - supporting and regulating ecosystem services;
  - sustainability and resilience;
- The application of an ecosystem approach;
- The state of the sustainable use of biodiversity for food and agriculture.

Since the sectoral State of the World reports already presented or in preparation provide information separately on the use of animal, aquatic, forest and plant genetic resources, the responses here should provide available information on:

- The combined use of genetic resources coming from different sectors;
- Synergies between genetic resources of the different sectors
- The use of all types of associated biodiversity, either as separate components or in combination;
- The use of wild foods and, where information exists, other important wild harvested products.

The uses of biodiversity for food and agriculture can include:

- The direct use of genetic resources from different sectors or of associated biodiversity and wild foods, individually or in combination;
- The indirect use through the provision of supporting and regulating ecosystem services;
- The support for land/water restoration or other land/water management objectives;
- The support of cultural ecosystem services including:
  - Use for cultural, amenity or social reasons;
  - Use in education or scientific research.

To help reporting and provide a common framework for analysis of Country Reports a set of biodiversity maintaining management practices and diversity based practices have been identified in Annex 5 and Annex 6. These provide a framework for a number of the questions in this Chapter.

The information provided for this Chapter should also cover the adoption of an ecosystem approach. One such approach has been developed under the Convention on Biological Diversity and comprises 12 principles.

A final section of this Chapter of the Country Report should address the sustainable use of different components of biodiversity for food and agriculture, wild foods and other wild harvested products.

Where information is available, comment on the different roles played by men and women in the use of genetic resources, use and consumption of wild foods and knowledge over local ecosystems.

The use of management practices or actions that favor or involve the use of biodiversity for food and agriculture

This section looks for information on the extent to which biodiversity maintaining management practices and diversity based practices are in use in your country.

52. **For each of the production systems present in your country indicate in Table 20 the extent of use of management practices that are considered to favor the maintenance and use of biodiversity for food and agriculture.**

In the table indicate the percent of total production area or quantity under the practice (where known), changes that have occurred over the last 10 years in the production area or quantity under the practice (significant increase (2), some increase (1), no change (0), some decrease (-1), significant decrease (-2), not known (NK), not applicable (NA)), and any identified change in biodiversity for food and agriculture associated with the practice (strongly increasing (2) increasing (1), stable (0) decreasing (-1), strongly decreasing (-2), not known (NK), not applicable (NA)).

Table 20. Management practices that are considered to favor the maintenance and use of biodiversity for food and agriculture.

Production systems	**Management practices** (Place pointer on the management practice name for a description)	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK, NA)**
Livestock grassland-based systems: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Livestock grassland-based systems: Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			

	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Livestock grassland-based systems: Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Livestock grassland-based systems: Boreal and /or highlands	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			

	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Livestock landless systems: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Livestock landless systems: Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			

	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Livestock landless systems: Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Livestock landless systems: Boreal and /or highlands	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			

	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Naturally regenerated forests: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Naturally regenerated forests: Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			

	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Naturally regenerated forests: Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Planted forests: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			

	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Planted forests: Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Planted forests: Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			

	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Self-recruiting capture fisheries: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	100	1	0
	Conservation hatcheries	10	1	1
	Reduced-impact logging			
	Other [*please specify*]:			
Self-recruiting capture fisheries: Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	70	1	0
	Conservation hatcheries	10	1	1

	Reduced-impact logging			
	Other [*please specify*]:			
Self-recruiting capture fisheries: Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	50	0	0
	Conservation hatcheries	10	1	1
	Reduced-impact logging			
	Other [*please specify*]:			
Culture-based fisheries: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	75	1	1
	Conservation hatcheries	10	1	1
	Reduced-impact logging			

	Other [*please specify*]:			
Culture-based fisheries: Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	50	1	0
	Conservation hatcheries	10	1	1
	Reduced-impact logging			
	Other [*please specify*]:			
Fed aquaculture: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	10	1	0
	Conservation hatcheries	10	1	1
	Reduced-impact logging			
	Other [*please specify*]:			
Fed aquaculture: Subtropics	Integrated Plant Nutrient Management (IPNM)			

	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	10	1	0
	Conservation hatcheries	10	1	1
	Reduced-impact logging			
	Other [*please specify*]:			
Fed aquaculture: Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	0	0	0
	Conservation hatcheries	10	1	0
	Reduced-impact logging			
	Other [*please specify*]:			
Non-fed aquaculture: Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			

	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	NK	NK	NK
	Conservation hatcheries	NK	NK	NK
	Reduced-impact logging			
	Other [*please specify*]:			
Non-fed aquaculture: Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	NK	NK	NK
	Conservation hatcheries	NK	NK	NK
	Reduced-impact logging			
	Other [*please specify*]:			
Irrigated crops (other) : Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			

	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Irrigated crops (other) : Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Irrigated crops (other) : Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			

	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Irrigated crops (other) : Boreal and /or highlands	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Rainfed crops : Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			

	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Rainfed crops : Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Rainfed crops : Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			

	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Rainfed crops : Boreal and /or highlands	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			

	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	50	1	0
	Conservation hatcheries	10	1	1
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries	50	1	0
	Conservation hatcheries	10	1	0
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			

	Organic agriculture			
	Low external input agriculture			
	Home gardens		0	0
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]: Livestock improvement and health management		1	1
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			
	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			
	Integrated Plant Nutrient Management (IPNM)			
	Integrated Pest Management (IPM)			
	Pollination management			
	Landscape management			
	Sustainable soil management practices			
	Conservation agriculture			
	Water management practices, water harvesting			
	Agroforestry			

	Organic agriculture			
	Low external input agriculture			
	Home gardens			
	Areas designated by virtue of production features and approaches			
	Ecosystem approach to capture fisheries			
	Conservation hatcheries			
	Reduced-impact logging			
	Other [*please specify*]:			

Provide or cite references to any documentary evidence that exists to support the evaluation given above. Indicate where practices used in a production system are affecting biodiversity for food and agriculture in another production system.

Where evidence exists of an effect of any of these practices on biodiversity for food and agriculture, provide a brief summary of the effect, the components of biodiversity for food and agriculture affected, and available indicators. Include any available references or reports.

Ranching of native fishes namely Horabagrus brachysoma, Etroplus suratensis, Labeo dussumieri and Macrobrachium rosenbergii have substantially increased production from Vembnad lake, Kerala.

53. **For each of the production systems present in your country indicate in Table 21 the extent of use of diversity based practices that involve the use of biodiversity for food and agriculture.**

In each table indicate the percent of total production area or quantity under the practice (where known), changes in the production area or quantity under the practice that have occurred over the last 10 years (strongly increasing (2), increasing (1), stable (0) decreasing (-1), strongly decreasing (-2), not known (NK)) and any identified change in biodiversity for food and agriculture associated with the diversity based practice (strongly increasing (2) increasing (1), stable (0) decreasing (-1), strongly decreasing (-2), not known (NK)).

Table 21. Diversity based practices that involve the enhanced use of biodiversity for food and agriculture.

Production systems	**Diversity based practices** (Place pointer on the diversity based practice name for a description)	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK, NA)**
Livestock grassland-based systems: Tropics	Diversification	NK	1	1
	Base broadening	NK	1	1
	Domestication	NK	0	0
	Maintenance or conservation of landcape complexity	NK	0	0
	Restoration practices	NA	NA	NA
	Management of microorganisms	NK	1	1
	Polyculture/Aquaponics	NA	NA	NA
	Swidden and shifting cultivation agriculture	NA	NA	NA

	Enriched forests	NA	NA	NA
	Other [*please specify*]:			
Livestock grassland-based systems: Subtropics	Diversification	NK	1	1
	Base broadening	NK	1	1
	Domestication	NK	0	0
	Maintenance or conservation of landcape complexity	NK	0	0
	Restoration practices	NA	NA	NA
	Management of microorganisms	NK	1	1
	Polyculture/Aquaponics	NA	NA	NA
	Swidden and shifting cultivation agriculture	NA	NA	NA
	Enriched forests	NA	NA	NA
	Other [*please specify*]:			
Livestock grassland-based systems: Temperate	Diversification	NK	1	1
	Base broadening	NK	1	1
	Domestication	NK	0	0
	Maintenance or conservation of landcape complexity	NK	0	0
	Restoration practices	NA	NA	NA
	Management of microorganisms	NK	1	1
	Polyculture/Aquaponics	NA	NA	NA
	Swidden and shifting cultivation agriculture	NA	NA	NA
	Enriched forests	NA	NA	NA
	Other [*please specify*]:			
Livestock grassland-based systems: Boreal and /or highlands	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			

Livestock landless systems: Tropics	Diversification	NK	1	1
	Base broadening	NK	1	1
	Domestication	NK	0	0
	Maintenance or conservation of landcape complexity	NK	0	0
	Restoration practices	NA	NA	NA
	Management of microorganisms	NK	1	1
	Polyculture/Aquaponics	NA	NA	NA
	Swidden and shifting cultivation agriculture	NA	NA	NA
	Enriched forests	NA	NA	NA
	Other [*please specify*]:			
Livestock landless systems: Subtropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Livestock landless systems: Temperate	Diversification	NK	1	1
	Base broadening	NK	1	1
	Domestication	NK	0	0
	Maintenance or conservation of landcape complexity	NK	0	0
	Restoration practices	NA	NA	NA
	Management of microorganisms	NK	1	1
	Polyculture/Aquaponics	NA	NA	NA
	Swidden and shifting cultivation agriculture	NA	NA	NA
	Enriched forests	NA	NA	NA
	Other [*please specify*]:			
Livestock landless systems: Boreal and /or highlands	Diversification			
	Base broadening			

	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Naturally regenerated forests: Tropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Naturally regenerated forests: Subtropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Naturally regenerated forests: Temperate	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			

	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Planted forests: Tropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Planted forests: Subtropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Planted forests: Temperate	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			

	Enriched forests			
	Other [*please specify*]:			
Self-recruiting capture fisheries: Tropics	Diversification	NK	NK	NK
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Self-recruiting capture fisheries: Subtropics	Diversification	NK	NK	NK
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Self-recruiting capture fisheries: Temperate	Diversification	NK	NK	NK
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Culture-based fisheries: Tropics	Diversification	20%	1	1

	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Culture-based fisheries: Subtropics	Diversification	20%	1	1
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Fed aquaculture: Tropics	Diversification	50%	2	2
	Base broadening			
	Domestication	10	1	1
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics	30%	1	1
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Fed aquaculture: Subtropics	Diversification	10	0	0
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			

	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics	10	1	1
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Fed aquaculture: Temperate	Diversification	10	1	1
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Non-fed aquaculture: Tropics	Diversification	10	NK	NK
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics	10	0	0
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Non-fed aquaculture: Subtropics	Diversification	0	NK	NK
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			

	Enriched forests			
	Other [*please specify*]:			
Irrigated crops (other) : Tropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Irrigated crops (other) : Subtropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Irrigated crops (other) : Temperate	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Irrigated crops (other) : Boreal and /or highlands	Diversification			

	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Rainfed crops : Tropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Rainfed crops : Subtropics	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Rainfed crops : Temperate	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			

	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Rainfed crops : Boreal and /or highlands	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	Diversification	NK	1	1
	Base broadening	NK	1	1
	Domestication	NK	0	0
	Maintenance or conservation of landcape complexity	NK	0	0
	Restoration practices	NA	NA	NA
	Management of microorganisms	NK	1	1
	Polyculture/Aquaponics	NA	NA	NA
	Swidden and shifting cultivation agriculture	NA	NA	NA
	Enriched forests	NA	NA	NA
	Other [*please specify*]:			
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	Diversification	0	NK	NK
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			

	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	Diversification	NK	1	1
	Base broadening	NK	1	1
	Domestication	NK	0	0
	Maintenance or conservation of landcape complexity	NK	0	0
	Restoration practices	NA	NA	NA
	Management of microorganisms	NK	1	1
	Polyculture/Aquaponics	NA	NA	NA
	Swidden and shifting cultivation agriculture	NA	NA	NA
	Enriched forests	NA	NA	NA
	Other [*please specify*]:			
Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			
	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			
	Diversification			
	Base broadening			
	Domestication			
	Maintenance or conservation of landcape complexity			
	Restoration practices			
	Management of microorganisms			

	Polyculture/Aquaponics			
	Swidden and shifting cultivation agriculture			
	Enriched forests			
	Other [*please specify*]:			

Briefly summarize the information that exists on the effect of the diversity based practice on different components of biodiversity for food and agriculture. Indicate where practices used in a production system are affecting biodiversity for food and agriculture in another production system. Include any available references or reports to support the evaluation given above.

Diversification of species has increased biodiversity for food in tropical and sub-tropical self recruiting capture fisheries. Similarly, species diversification in fed-aquaculture in the tropics (Littopenaeus vannamei) and sub-tropics (Pangasionodon hypophthalmus) has enhanced the food basket in these productions systems.

54. **List and briefly describe any specific programmes or projects that have been undertaken in the country to support any of the practices listed in Table 20 and Table 21. Provide information where available on what types of activities were supported, areas and numbers of farmers, pastoralists, forest dwellers and fisherfolk involved, state and outcome with respect to components of biodiversity for food and agriculture.**

Introduction of Penaeus vannamei in Fed Aquaculture-Tropics increased shrimp production by more than 50%. Introduction of Oreochromis niloticus (GIFT tilapia) and Pangasianodon hypophthalamus increased production by 25% in freshwater aquaculture.

Sustainable use of biodiversity for food and agriculture

Sustainable use of biodiversity for food and agriculture ensures its utilization in ways that do not compromise its continuing availability and its use by future generations. Sector reports will provide information on sustainable use of the different sector genetic resources. Here the focus is therefore on associated biodiversity and on wild foods.

55. **What are the major practices in your country that negatively impact associated biodiversity and/or wild foods? Answers can be provided in Table 22 where examples of general types of practices are listed.**

Table 22. Major practices that negatively impact associated biodiversity and/or wild foods in the country.

Types of practices	Major practice (Y/N)	Description	Reference
Over-use of artificial fertilizers or external inputs			
Over-use of chemical control mechanisms (e.g. disease control agents, pesticides, herbicides, veterinary drugs, etc.)	Y	In India, ticks and ticks borne disease in livestock are quite prevalent. The acaricides are the most commonly used drug to control ticks infestations in cattle and buffaloes. Organophosphates, pyrethroids, formamidines and macrocyclic lactones are the 4 major types of chemical acaricides which are the mainstay of tick control programme in India. The rampant use of these pesticides sometimes poses danger of acute poisoning of treated animals. Such type of treatment may also contaminate meat, milk, water resources as well as the environment. The ticks are acquiring resistance due to overuse of these acaricides. The control of ticks and tick borne diseases are major cause of concern in livestock sector.Intensive and repeated use of insecticides	

Inappropriate water management	Y	The reason for inappropriate water management is both natural and human-induced. The states like West Bengal, Orissa, Andhra Pradesh, Kerala, Assam, Bihar, Gujrat, Uttar Pradesh, Haryana and Punjab get frequent flood. The southwest monsoon causes Brahmaputra, Ganga, Yamuna etc. rivers to swell their banks, which in turn floods the adjacent areas. Over the last decade or so, this kind of situation in several flood prone states is greatly affecting the livestock population. On the other hand, the arid or semi-arid areas of country are always facing shortage of drinking water for livestock. In these regions, large areas have been rendered barren due to poor irrigation and drainage management system in place.	
Practices leading to soil and water degradation			
Over-grazing	Y	In last decade or so, heavy grazing by different livestock species is causing depletion in plant diversity along with soil degradation and erosion especially in arid and semi-arid areas. Due to over grazing and high livestock density, the arid and semi-arid regions of the country, have shown higher rate of soil erosion. Also, due to rapid urbanization and infrastructure development, substantial amount of lands traditionally being utilized for agriculture practices, forest, as grassland and as pasture land may get reduced. In future, this may affect the livestock as well as overall bio-diversity of the country.	
Uncontrolled forest clearing		The over-exploitation and unsustainable use of forests resources mainly for commercial development is leading to habitat destruction. This will definitely have an impact on livestock genetic resources as well as on overall biodiversity. For mining and for other 'developmental activities' large tracts are cleared	

Fishing in protected areas	Y	Fishing in protected areas may cause loss in diversity of livestock of a particular region. For example, population of some of the breeds like Chilika buffaloes in Odissa state are getting affected. In recent years, more preferences are given to prawn cultivation in the breeding tract of Chilika buffaloes. The buffaloes are not allowed to enter the ponds designated for prawn cultivation. Due to this, the local farmers have limited options to graze their animals in the wet land. This is causing decline in population of this unique buffalo breed which is so well adapted to saline condition. These buffaloes are unique as they mostly sustain on weeds grown in backwaters of Chilika lake. Harvesting juveniles and brooders negatively impact the self recruitment in the system.	
Overharvesting			
Other [*please specify*): indiscriminate cross breeding	Y	In the absence of proper awareness about the importance to conserve and maintain purebred indigenous populations, indiscriminate crossbreeding within native stock and exotic breeds has continued in the country. Extensive use of exotic germplasm (Holstein and Jersey semen) in AI programmes across country is diluting the native germplasm. Due to indiscriminate cross-breeding the population of exotic/crossbred cattle has increased from 14.4 million to 19.42 million, an increase of 34.78 % (19th Livestock Census- 2012). Although, the crossbreeding has played significant role in attaining India's top position as highest milk producer country of the world, it has resulted in significant loss of native cattle genepool. The proportion of cross-bred populations has also increased for species like pig and poultry with infusion of exotic germplasm mostly for commercial purposes. Habitat alteration favours exotic fishes such as Cyprinus carpio and tilapia and negatively affect the indigenous fishes.	
Other [*please specify*):Small Land holdings	Y	In India, small land holdings particularly in rainfed area are a prominent feature. About 87.7% of livestock are maintained by farmers with<4 ha. The small land holdings, and poverty, together lead to non-sustainable land management practices. This is the major cause for land degradation and poor availability of green feed and fodder for livestock rearing. Also due to fast increase in human, as well as livestock population, there has already been heavy pressures on country's limited land resources.	

Other [*please specify*):			

Add row

Delete row

Please comment on the reasons why the practices are in use and discuss if trade-offs are involved.

The fertility of the soils has declined over the years. The recommeded doses of fertilizers for some of the crops have increased. In order to achieve the same amount of yield, more and more chemical fertilizers are used. Likewise different races of pathogens and insect pests have evolved over the years and new molecules are developed every year and used as pesticides and insecticides for the control of insect pests.

In India, number of crafts and gears are more than the carrying capacity, hence, overfishing of the species which hampers the self recruitment and fisheries. Change in land use pattern and habitat alteration favours for those species which have more plasticity, mostly exotic fishes.

56. **Briefly describe any actions and countermeasures taken to limit unsustainable use and/or support sustainable use of associated biodiversity and/or wild foods.**

Excessive and non-judicious use agrochemicals has adversely affected quality of soil and environment in unsustainable way. Use of organic inputs including bioinoculants in agriculture would reduce consumption of chemical inputs resulting in improvement in soil health and crop productivity. Development of microbe based biopesticides for control of fungal pathogens and insect pests would also help in sustainable use of associated biodiversity.

Several areas have been declared as protected areas under the provisions of Indian Fisheries Act 1897, Coastal Aquaculture Authority Act 2005, Marine Fishing Policy 2004 and Wetland Rules 2010, Biodiversity Act 2002 and Rules 2004. Under these Acts, registration and licensing of crafts and gears and farms are mandatory for sustainable use of biodiversity.

57. **Provide in Table 23 any information available that lack of biodiversity for food and agriculture is limiting food security and nutrition, and/or rural livelihoods in the different production systems in your country. Indicate the production systems affected together with any information on the extent of problem (significant lack (2), some lack (1)), describe the effects on livelihood, food security and nutrition, and the components of biodiversity for food and agriculture that are limited.**

Table 23. Effect of the lack of biodiversity for food and agriculture on production, food security and nutrition and livelihood.

Production system	Biodiversity component for which diversity is lacking	Extent of problem (2,1)	Effect on food security and nutrition	Effect on livelihood	Reference
Fed Aquaculture-Temperate	Vertebrates (fishes)	1	Moderate	Moderate	
Self recruitment Fisheries- Temperate	Vertebrates (fishes)	1	Moderate	Moderate	

Add row

Delete row

The contribution of biodiversity for food and agriculture to improving productivity, food security and nutrition, livelihoods, ecosystem services, sustainability, resilience and sustainable intensification

This section looks for information on the direct contributions of biodiversity for food and agriculture to improving productivity, food security and nutrition, livelihoods, ecosystem services, sustainability, resilience and sustainable intensification. It is concerned specifically with the combined use of genetic resources coming from different sectors, the use of all types of associated biodiversity, the use of wild foods and, where information exists, other important wild products.

Note the ways in which biodiversity for food and agriculture contributes to food security and nutrition, livelihoods, ecosystem services, sustainability, resilience and sustainable intensification are often linked. Answers to the requests for information below may therefore be combined.

58. **Where available, provide information that increasing the amount of biodiversity for food and agriculture, including associated biodiversity, in production systems in your country have improved the following:**

a) productivity;
b) food security and nutrition;
c) rural livelihoods;
d) ecosystem services;
e) sustainability;
f) resilience;
g) sustainable intensification.

What specific actions have you undertake to strengthen the contribution of biodiversity for food and agriculture to improving these outcomes? For each of these aspects, briefly describe the nature and scale of the actions implemented, the production systems involved, and the outcomes, results obtained or lessons learned from these actions.

Where available provide information on the components of biodiversity for food and agriculture involved, the stakeholders involved and the gender aspects of these actions. Note that information on policies, legislation or regulations should be reported in Chapter 5 and your response here should be concerned with interventions at production system level.

Productivity

Over the years, the livestock and poultry genetic resources have been the important component of food security and livelihood in India. Their utility as source of food (milk, meat and eggs), shelter and protection (fiber and hives), power (draught and transportation), fuel and fertilizer (manure) has been widely recognized. In India, livestock production and agriculture are intrinsically linked and both are considered crucial for overall food security. India's livestock sector is one of the largest in the world with 512.2 million livestock and 729.2 million total poultry. It has 56.7% of world's buffalo populations (108.7 million), 12.5% cattle (190.9 million), 20.4% small ruminants (65.07 million sheep plus 135.2 million goats), 2.4% camel, 1.4% equine, 1.5% pigs (10.3 million) and 3.1% poultry (729.2 million) (19th livestock census). India is first in the total buffalo population in the world, second in the population of cattle and goats, third in the population of sheep (72 millions), fifth in in the population of ducks and chicken and tenth in camel population in the world.

India continues to be the largest producer of milk in world. At the end of Tenth Plan (2006-07) the milk production was 102.6 million tonnes which increased to 127.9 million tonnes at the end of the Eleventh Plan (2011-12). Milk production during 2012-13 and 2013-14 was 132.4 million tonnes and 137.7 million tonnes, respectively with an annual growth rate of 3.54% and 3.97%, respectively. The average per day milk yield recorded for major livestock species in India are: crossbred/exotic cattle 6.78 kg/day; indigenous/nondescript cows: 2.78 kg/day; buffaloes: 4.91 kg/day; and goat: 0.45 kg/day. The per capita availability of milk is around 307 grams per day in 2013-14.

Similarly in last 2-3 decades, poultry production in India has taken a quantum leap. Egg production at the end of the Tenth Plan (2006) was 50.66 billion as compared to 66.45 billion at the end of the Eleventh Plan (2011-12). The total egg production in 2013- 14 was around 74.75 billion. The per capita availability of egg in 2013- 14 was around 61 eggs. The poultry meat production was estimated to be 2.69 million metric tonnes. Exports of poultry products were worth around R 566 crore in 2013-14 as per Agricultural and Processed Food Products Export Development Authority (APEDA).

The Meat production in India has registered a steady growth from 2.3 million tonnes at the end of Tenth Five Year Plan (2006-07) to 5.5 million tonnes at the end of the Eleventh Five Year Plan (2011-12). Meat production in the beginning of Twelfth Plan (2012-13) was 5.9 million tonnes which has been further increased to 6.2 million tonnes in 2013-14. Buffalo in India contributes about 30% of total meat production. The contribution by cattle, sheep, goats and poultry is 30%, 5%, 10%, 10.2% and 11.5%, respectively.

India has lot of potential in fish production due to its long coastline of about 8,118 km apart from the inland water resources. India is the second largest producer of fish and also second largest producer of fresh water fish in the world. Fish production has increased from 41.57 lakh tonnes (24.47 lakh tonnes for marine and 17.10 lakh tonnes for inland fisheries) in 1991-92 to

95.79 lakh tonnes (34.43 lakh tonnes for marine and 61.36 lakh tonnes for inland fisheries) in 2013-14. As per the estimates of CSO, the gross value added from fisheries sector during 2013-14 was R 96,824 crore which was about 5.15% of the gross value added from agriculture, forestry and fishing sectors.
Besides, the livestock in India also contributes to the production of wool, hair, hides, and pelts. The wool production was 46.1 million Kg in the beginning of Twelfth Plan (2012-13) which was increased to 47.9 million Kg in 2013-14 with an annual growth rate for 4.03%. In addition, dung and other wastes from livestock and poultry serve as very good farm yard manure and the value of it is worth several crores of rupees. It is also used as source for fuel (bio gas, dung cakes) especially in rural India.
(Source: Annual Report 2014-15, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture and Farmers Welfare, Govt. of India.)

Food security and nutrition
In the past decade or so, Indian livestock share in agricultural sector GDP growth has been increasing faster than the crop sector. The livestock production and agriculture sectors in India are intrinsically linked, each being dependent on the other, and both crucial for overall food security. According to estimates of the Central Statistics Office (CSO), the livestock sector is contributing about 3.88% of total gross value added of the country. The gross value added from livestock sector was about Rs. 4,06,035 crore during 2013-14 which was about 21.58% of the gross value added from total agriculture, forestry and fishing sectors. In 2013-14, the livestock sector was expanded by 5.5% against the total agriculture, forestry and fishing sectors growth of 3.7%. Nearly 90% of livestock production in India is managed by more than 100 million smallholder farmers. This signifies the role that livestock play in poverty reduction and food and nutrition security directly through increased consumption of milk/meat products and indirectly through increased income/ employment generation. It is now a widely recognized fact that consumption of livestock products can play a vital role to improve diet quality and malnutrition in rural as well as urban India. In recent years, the increase consumption of various livestock products being rich source of proteins, vitamins and several micronutrients are expected to have positive impact on nutrition and health of rural people. In addition, livestock is also making indirect contribution to food security through manure. In some part of the country, the addition of manure and animal wastes as a source of organic plant nutrients has reduced the need for chemical fertilizers and helped in increasing the crop output. However, at this stage, drawing the clear association ship between poverty, malnutrition, and consumption of livestock products will be a difficult task as each of these are further dependent on several other inter-linked factors.

Rural livelihood
In most parts of India, livestock rearing has always been the hallmark of rural culture. This is indicative of the fact that rural families have always realized the importance of livestock. In the absence of fertile lands, low productivity and high uncertainty in crop production and assured irrigation, most of the rural families belonging to socio-economically weaker sections of the society maintain different species of livestock to support their livelihood. The livestock rearing is contributing to the livelihood in several ways; generating income from products, insurance against drought, providing nutrition, fuel for cooking, manure for crops, draught power for farming etc. In India, smallholders and landless together manage over 75% of country's livestock resources and obtain nearly half of their income from livestock. Livestock resources are mainly concentrated among the marginal and small landholders and therefore it is expected that any growth in the livestock sector would be beneficial to the small holders.

Ecosystem services
In India, due to existing mega biodiversity and associated bio diversities, several key ecosystem services are in place. These ecosystems services such as nutrient cycling, pest regulation and pollination are directly or indirectly helping in sustaining the agricultural and livestock productivity. Though, various ecosystem services might have helped in enhancing the production of crops, livestock and fish stocks over the last 50 years, their exact valuation and impact particularly related to livestock productivity is not known at present moment.

Sustainability
Livestock are an integral component of agriculture in India and make multifaceted contributions in sustaining the agricultural sector of the country. In this context, livestock has major contribution to the efficient use of available natural resources. Livestock and poultry genetic resources of the country are not only helping in improving food and nutritional security by providing nutrient-rich food products, they also generate income and employment and act as a cushion against crop failure, provide draught power and manure. Additionally, livestock make substantial contributions to environmental conservation, supplying draught power and manure for fertilizer and domestic fuel that save on the use of petro-products. The vast livestock and poultry genetic resources have become an important source of fertilizer and soil conditioner. As nutrient recycling is a very important component of any sustainable farming system, the integration of livestock and crops especially in the mixed farming system of the country are helping in great deal in efficient nutrient recycling. Animals use the crop residues as feed, such as cereal straws, as well as maize and sorghum stovers. The manure in turn produced by the livestock is recycled directly as fertilizer. This has resulted in dual benefit; increased crop production and reduced application of chemical fertilizer. In many parts of the country, millions of farmers now use cow dung as fuel for cooking and this represents the major fuel supply for general household use. In our country, every year 300 million tonnes of dung are used for fuel. In addition, biogas production from manure has also become popular practice among the rural masses and is an excellent substitute for fuelwood. It is considered person-friendly especially for women because of its convenience and increased hygiene, and it also provides a number of services, such as lighting, warm water and heating. The cattle, buffaloes, camel, equines are also being used as important sources of draught power for a variety of purposes, such as agricultural operations, pumping irrigation water and

transportation. In India, still the majority of the cultivated area is farmed using draught animals. Draught animals remain the most cost-effective power source for small and medium-scale farmers. It is expected that even increase in mechanization, draught animal power will continue to remain important for substantial part of the country.
Local breeds are important to meet food security under low- or zero-input production systems as they harbor genetic diversity to mitigate anticipated changes in food quantity and quality demand in future with respect to climate change. Currently, there is a growing demand for livestock products, and production systems are changing and intensifying to meet this demand. As a consequence, a few high-input and high-output livestock breeds are dominating while indigenous breeds are decreasing in numbers. Hence, it is imperative to conserve and improve the native breeds that are well adapted to local conditions for their sustainable utilization.

Resilience
India is bestowed with immense richness of livestock and poultry diversity. The farm animal genetic resources in India are represented by a broad spectrum of native breeds of cattle, buffaloes, goat, sheep, swine, equines, camels, yak, mithun and poultry. These diverse ranges of livestock breeds are adapted to various extremes of climatic conditions and resource availability. Many of these breeds have potential to not only survive but also sustain production, reproduction and draft power under various climatic conditions and some breeds have unique attributes. The Indian native cattle viz. Tharparkar, Rathi, Gir, Nagori etc. can survive in arid agroclimatic region. Kankrej is another important cattle breed, known for its adaptability to high temperature, powerful draft capacity and resistance to tick borne disease.
Similarly, India has excellent and diverse buffalo germplasm, known for high fat rich milk (Murrah); very high milk fat (Bhadawari); adapted to brakish-water salinity conditions (Chilika); drought tolerant, adapted to hot-dry climate and nocturnal grazing (Banni buffaloes of Kutch-Gujarat); excellent draft power(Swamp buffaloes of north-east India).
The type of diversity that exists in our sheep breeds is also noteworthy. Garole sheep is known world-over for its prolificacy and adaptation to mangrove ecology. On the other hand, Malpura, Chokla, Marwari sheep and many other breeds from arid zones are well adapted to desert conditions. Many breeds of goat are also adapted to different ecological niche with high temperature, humidity or both for example; Andaman goat is adapted to saline conditions, Changthangi is adapted to higher altitude, whereas Jakhrana is well acclimatized to semi-arid condition. Further, Zanskari, Spiti breeds of horses and double hump camel are well known for working ability under hypoxic conditions at higher altitude. Several native populations of poultry viz., Ankleshwar, Assel, Punjab brown, Kadaknath etc. are known respectively for their hardiness, inherent fighting quality, egg and meat qualities.
These diverse livestock species with unique characteristics such as subsistence on poor quality feed and fodder, superior thermo-tolerance and better resistance to tropical diseases and parasitic infestations than their exotic counterparts could offer tremendous opportunities in the era of globalization and concerns arising from climate change. However, due to haphazard and indiscriminate cross breeding in lieu of high milk production, the unique thermotolerant ability/ of our native breeds might get diluted in future.

Sustainable intensification
Not known

The use of biofertilzers and biopesticides have contributed to the improvement of soil fertility by providing major nutrients like NPK through nitrogen fixation, P and K solubilization and mobilization. The ecosystem services provided by microorganisms are immense and they are an integral component of all biogeochemical cycles.
Due to gradual environmental degradation, government of India has promoted organic agriculture in the country especially the North eastern states have been declared organic for improving soil organic carbon, nutrient status and thereby reducing level of toxic material in food and feed.

India utilise less than 5% of its fish diversity in the culture systems, where as we have more than 3500 species of fishes, crustaceans and molluscs. In most of the coastal areas, people depend sea for food and nutrition and more than 300 species are utilised as food. More than 25 species of fish and fishery products are currently exported from India to world. Recent introductions of Malayasian catfish, Panagasianodon hypophthalmus and white leg shrimp, Litopenaeus vannamei brought a good production in aquaculture. At present in total export, shrimp contribute more than 80% by volume and Litopenaeus vannamei contribute the maximum share. This has improved the livelihood of the fisherfolks and their nutrition. There is a strict monitoring of introduction of Litopenaeus vannamei in India. This check the uncontrollable farming activities and sustainable production.

59. **Do you have information on the proportion of the population in your country that uses wild food on a regular basis for food and nutrition? If available, include information such as the proportion of the diet that is collected from the wild in normal time and in times of scarcity, drought, natural and human-made disaster, and the degree to which wild foods are used (for subsistence, supplementing, nutrition, other).**

Provide explanations and additional information as regards the gender differences in the patterns of use, management and consumption of wild food, including data disaggregated by sex.

NK

The adoption of ecosystem approaches

60. **Describe in Table 24 the extent to which you consider that ecosystem approaches have been adopted for the different production systems in your country (widely adopted (2), partially adopted (1), not adopted (0), not applicable (NA)) and indicate whether ecosystem approaches are considered of major importance (2), some importance (1), no importance (0), not applicable (NA). You may also want to describe landscape approaches that have been adopted in your country.**

Table 24. Adoption of and importance assigned to ecosystem approaches in production systems in the Country.

Production system	Ecosystem approach adopted (name)	Extent of adoption (2,1,0,NA)	Importance assigned to the ecosystem approach (2,1,0,NA)
Self-recruiting capture fisheries-Tropics	Declaration of protected areas, Implementation for code of conduct for responsible fisheries (CCRF)	2	2
Self-recruiting capture fisheries-subtropics	Declaration of protected areas	2	2
Self-recruiting capture fisheries-Temperate	Declaration of protected areas	2	2
Culture-based fisheries- Tropics	Declaration of protected areas	1	1
Culture-based fisheries-Subtropics	Declaration of protected areas	1	1
Fed Aquaculture- Tropics	Coastal regulation zone for aquaculture ponds	2	2

Add row

Delete row

61. **For each production system in which an ecosystem and landscape approach has been widely adopted (as indicated in Table 24) describe:**
   a. **The specific actions that have been taken to ensure adoption;**
   b. **Any observed results from adoption;**
   c. **Plans for adoption or for further adoption in new or existing production areas;**
   d. **Lessons learned.**

In India 605 protected areas covering approximately 5.2% of the total geographical area are under in-situ conservation through a protected area network of 96 National Parks, 509 Wildlife Sanctuaries and 3 Conservation Reserves established under the Wildlife (Protection) Act. Unlike sanctuaries for terrestrial animals and wildlife, the available sanctuaries for aquatic resources 'are limited and creation of such sanctuaries and protected areas for fish are necessary for in-situ conservation. Even within wildlife sanctuaries, there is less protection for fishes and scientific management practices are lacking. Marine Reserves have been used to conserve fish populations that are threatened by intensive fishing. In India, there are four important National Marine Parks: (i) Gulf of Kachchh National Marine Park (established in 1980; Okha to Jodia, Gujarat coast covering 42 islands; area 400 km-), (ii) Gulf of Mannar National Marine Park (established in 1986; Rameswaram to Tuticorin, Tarnil Nadu; area 623

ha), (iii) Wandoor Mahatma Gandhi National Marine Park (established in 1983; area 281.50 km-, South Andaman), and (iv) Rani Jhansi Marine National Park (established in 1996; area 256.14 km", Andaman) and 3 important Marine Sanctuaries- Bhitarkanika Gahirmatha Sanctuary (established in 1997; area 1,435 km2, Odisha) , Malvan Marine Sanctuary (established in 1987; area 29.12 krn-, Maharashtra), and Gulf of Kachchh (established in 1980, area 295.03 km-, Gujarat). There are also 4 important biosphere reserves, viz. Sunderbans (established in 1989; 9630 km-, West Bengal), Gulf of Mannar (established in 1989, area 10,500 km-, Tamil Nadu), Great Nicobar (established in 1989; 885 km-, Andaman and Nicobar islands) and Kachchh (established in 2008; 12,454 km-, Gujarat) for conservation of representative ecosystem.

India became a contracting party to the Ramsar Convention in 1981, 25 wetlands in the country, represent different habitats, are designated as Ramsar Sites of International Importance. In Himachal Pradesh, where the landing of prized mahseer is declining fast, the Government of Himachal Pradesh has declared sanctuaries in Sidhpur and Machial (Mandi district), Renuka Lake (Sirmaur district), Baijnath and Chandra Tal (Kangra district) for protection of mahseer. Some river stretches throughout the country are also protected owing to religious sentiments as they are located in the vicinity of holy places and shrines (temples).

Gaps and priorities

62. **With respect to the use of management practices or actions that favor or involve the use of biodiversity for food and agriculture:**

a. **What are the major gaps in information and knowledge?**
b. **What are the main capacity or resources limitations?**
c. **What are the main policy and institutional constraints?**
d. **What actions are required and what would be the priorities?**

a. Major gaps in information and knowledge :
- Lack of pedigree and performance recording system at farmers herd
- Lack of breeding bulls of high genetic merit for each breed
- Lack of awareness among the livestock keepers for good management practices
- Limited interactive platforms between livestock keepers, researchers and entrepreneurs
- Lack of scientific data on positive attributes of indigenous livestock breeds
- Lack of breed societies to exploit the genetic potential and self-sustenance of a breed/population

b. What are the main capacity or resources limitations?
- Most of the indigenous livestock keepers are poor and illiterate.
- Lack of nucleus herds and field recording system for most of the breeds
- Lack of information on unique genetic resources/gene pool suitable in particular niche.
- Lack of proper infrastructure
- Shortage of trained manpower for characterization and conservation (in situ and ex situ) of valuable native germplasm.
- Limited support chain for value addition of indigenous resources and their products

c. What are the main policy and institutional constraints?
d. Inadequate funds/resources for providing breeding services like AI, animal health services and supply of green feed and fodder to local livestock populations
- Lack of pedigreed population with uniform phenotype recording about production, reproduction and other traits.
- Lack of strong networking amongst institutions/universities situated at specific agro climatic areas to generate comprehensive information on local native genetic resources.
- Lack of well-defined criteria for breed prioritization for conservation and improvement.

e. What actions are required and what would be the priorities?
- Identifying/redefining core breeding tract of individual breed.
- Adoption of villages in the breeding tract.
- Registration of animals true to the breed type.
- Establishment of breed societies for in situ conservation of breeds.
- Encouragement to farmers and stake holders to register their pure animals with society.
- Establishment of nucleus herd for each breed and developing field recording systems.
- Strengthening of existing herd.
- Incentives to the farmers for maintaining native AnGR in the form of AI services, health services and feed/fodder.
- Promotion of technologies for characterization and genetic improvement
- Biotechnological interventions to increase the productivity of native breeds to make them economically viable.
- Preservation of unique breed/population irrespective of its production potential as resource for important gene pool for disease resistance or adaptability

- Monitoring of AnGR to avoid loss or displacement for breeds/populations especially with small population size.
- Training of local livestock keepers for utilization/conservation of AnGR adapted to specific ecological niches.
- Creation of National databank for storage of all information pertaining to animal genetic resources.
- Strengthening of institutional/SAUs herds in terms of better infrastructure and superior germplasm.
- Provision for optimal maintenance of grassland and other feed/fodder resources

1. The extent of microbial diversity in different agroecological niches have yet to be identified.
2. The utilization of diversity explored so far has yet to be taken up on a mega scale.
3. The knowledge on the use of microbe based technologies needs to be disseminated through effective extension network.
4. The farmers or the major stakeholders needs to be educated about the use and importance of biodiversity.
5. No National policies are in place regarding the use of microbe based technologies.

Knowledge on fish diversity in India is available but the availability of fishes for culture and food is declining due to many factors. Though there are many fishes which have potential for culture, but breeding protocols and culture technologies are not available. The proper habitat and biological studies are lacking. India is a vast area and many places are not accessible for collection of fishes and in many areas proper technology is lacking for harvesting the fishes. Many policies are in place but proper implementation is lacking. Proper technologies should be developed for region specific species diversification of aquaculture.

63. **With respect to the sustainable use of biodiversity for food and agriculture:**
   a. **What are the major gaps in information and knowledge?**
   b. **What are the main capacity or resources limitations?**
   c. **What are the main policy and institutional constraints?**
   d. **What actions are required and what would be the priorities?**

f. Major gaps in information and knowledge :
- Inadequate knowledge about rapid structural changes in agriculture and food consumption patterns in the country
- Inadequate information/knowledge to prioritize the livestock and poultry breeds for conservation based on their uniqueness and population structure
- No systematic information on performance and pedigree recording of different breeds
- Lack of information about socio-economic and environmental challenges to harness the potential of livestock
- Inadequate plan to improve productivity in a huge population of low-producing animals
- Introduction of exotic germplasm especially in cattle, chicken and pig
- Decline in importance of livestock as source of draught power due to mechanization
- Decline in importance of livestock due to replacement of dung manure by chemical fertilizers

g. What are the main capacity or resources limitations?
- Inadequate high quality semen doses of genetically superior bulls of each breed
- Lack of modern semen processing facilities and semen stations in the breeding tract
- Inadequate marketing and processing infrastructure facilities to the livestock products
- Limited support chain for value addition of indigenous resources and their products
- Inadequate breeding policies under low production system
- Insufficient resources i.e. infrastructure, marketing, fodder etc. with small farmers
- Inadequate number of breed societies
- Shrinkage of grazing land

h. What are the main policy and institutional constraints?
- Inadequate funding and trained manpower for conservation of AnGR
- Lack of pedigreed population with uniform phenotype recording about production, reproduction and other traits.
- Inadequate coordination and interaction between the various stakeholders involved with animal genetic resources, such as the government agencies, breeding industry, livestock keepers, research institutes and civil society organizations
- Lack of well-defined criteria for breed prioritization for conservation and improvement.
- Creation of national information management system on AnGR
- Lack of proper marketing infrastructure in the breeding tract
- Less attention in breeding programmes for species like horse, donkey, camel, yak, and mithun
- Most of the breeding programmes for pig and poultry are aimed towards using exotic breeds, ignoring the purity of locally adapted populations.

i. What actions are required and what would be the priorities?
- Formulation of breed specific breeding policy.
- Farmers should regularly be provided superior males / germplasm of high genetic merit.
- Preparation of National watch list.

- Prevention of genetic dilution of locally adapted breeds
- Conservation of locally adapted breeds
- Provide legal framework of protection and conservation of AnGR
- All the livestock farms of State and Central Government may be declared as in-situ conservation centres.
- Increasing awareness of government provided veterinary services
- Creating awareness about roles and values of native animal genetic resources
- Establishing state of policies and legal frameworks for animal genetic resources
- Incentives to the farmers for maintaining native AnGR
- Improvement of socio-economic condition of livestock keepers
- Proper marketing infrastructure needs to be developed

The capture fisheries is the multi species system and the proper knowledge of mesh size regulations are required. In commercial fisheries, bycatch is not utilised and it is thrown back to sea, which could be reduced using bycatch reduction devices. Policies for sustainable use of biodiversity, such CCRF 2004, Biological diversity Act 2002 and Rules 2004 are in place but implementation level is low.
Proper monitoring and surveillance of the area where diversity is high and declaring breeding and nursery grounds as protected area are required.

64. **With respect to the contribution of biodiversity for food and agriculture to improving productivity, food security and nutrition, livelihoods, ecosystem services, sustainability, resilience and sustainable intensification:**

a. What are the major gaps in information and knowledge?
b. What are the main capacity or resources limitations?
c. What are the main policy and institutional constraints?
d. What actions are required and what would be the priorities?

a. Major gaps in information and knowledge:
- Inadequate scientific knowledge/basis about exact production potential of different breeds
- Inadequate knowledge to harness optimum benefits from diversified livestock and poultry genetic resources
- Inadequate information about potential of various livestock products in food and nutrition security
- The information about various ecosystem services and their impact on livestock productivity is not known.
- The resilience with respect to various extremes of climatic conditions and resource availability is not well understood for many breeds
- Inadequate information about multifaceted contributions by different breeds in sustaining the economy of the local region.
- Inadequate information about production and other characteristics of several lesser known populations of different species
- No information about genetic merit of males used for breeding especially with small farmers
- Lack of data on economics and sustainable utility of different breeds

b. What are the main capacity or resources limitations?
- Inadequate plan to improve productivity especially in lesser known breeds of different species
- Inadequate scientific infrastructure to carry out genetic evaluation on productivity potential for each of the breeds.
- Inadequate support for vets/paravets for supply of necessary inputs like liquid nitrogen, frozen semen, health care and technical guidance
- Inadequate infrastructure like semen station and marketing facilities in the breeding tract
- Absence of performance and pedigree recording at filed level
- Inadequate funds and limited fodder resources

c. What are the main policy and institutional constraints?
- Lack of field oriented improvement and conservation strategy for local breeds
- Inadequate coordination amongst various stakeholders/agencies engaged in livestock and poultry rearing
- Inadequate credit and insurance support.

d. What actions are required and what would be the priorities?
- Production of elite bull mothers and bull calves at all organized farms.
- Use of sexed semen/embryos for multiplication of elite progeny
- Support to Goshalas for breed conservation and production of elite animals
- Certification for all bulls under semen freezing for pedigree, performance and disease free status
- Promote technological inventions for adding value to livestock products
- Improve the database of livestock performance and products
- Strengthening infrastructure for clean milk production.
- Benefit of government schemes/programmes should reach to small farmers especially in remote areas.
- Systematic extension services to motivate and support small farmers to adopt animal husbandry as source of income generation.

- Holistic policy for making best use of opportunities at national and international levels

Fisheries forms the source of livelihood for more than 14 million people in India. India produced 10 million metric fish in the year 2015. Fish is one of the cheapest source of protein. Per capita consumption of fish In India is 9.5 kg per year. Though there are many species available from sea, the commercial importance are only for few species and other species are not explored. Deep sea fishery resources are there but proper technology is lacking for sustainable utilisation of these resources.
Policies for sustainable use of biodiversity, such CCRF 2004, Biological diversity Act 2002 and Rules 2004 are in place but implementation level is low.
Proper monitoring and surveillance of the area where diversity is high and declaring breeding and nursery grounds as protected area are required.

65. **With respect to the adoption of ecosystem approaches:**
   a. **What are the major gaps in information and knowledge?**
   b. **What are the main capacity or resources limitations?**
   c. **What are the main policy and institutional constraints?**
   d. **What actions are required and what would be the priorities?**

Policies for sustainable use of biodiversity, such CCRF 2004, Biological diversity Act 2002 and Rules 2004 are in place but implementation level is low.
Proper monitoring and surveillance of the area where diversity is high and declaring breeding and nursery grounds as protected area are required.
Lack of proper information on the boundaries and demarcation of protected areas, awareness on the conservation programmes among fisherfolk are lacking.

CHAPTER 5: The state of interventions on conservation and use of biodiversity for food and agriculture

Proposed structure of the chapter and information to be included in the Country Reports

The main objective of this chapter is to provide an assessment and analysis of national and local interventions and activities, along with the state of international collaboration, that support conservation and sustainable use of biodiversity for food and agriculture. The analysis of interventions specific to plant, animal, forest and aquatic genetic resources will be based on the information provided in the respective State of the World Reports.

Information on the following topics should be covered in the Country Report:

- National policies, programmes and enabling frameworks that support or influence conservation and sustainable use of biodiversity for food and agriculture and the provision of ecosystem services;
- Policies, programmes and enabling frameworks governing exchange, access and benefits;
- Information management;
- Local and informal-sector actors and initiatives;
- Availability of capacity and resources;
- Participation in international and regional policies, legal frameworks and collaboration with other countries;
- Knowledge generation and science for the management and sustainable use of biodiversity for food and agriculture.

National policies, programmes and enabling frameworks that support or influence conservation and sustainable use of biodiversity for food and agriculture and the provision of ecosystem services

66. **Identify and describe the main policies, programmes and enabling frameworks that support or specifically address the objectives below, briefly describing the policies, programmes or enabling frameworks listed and provide any available information on the extent of implementation or of lessons learned. For each objective, list up to 10 major policies, programmes and enabling frameworks.**
   a. **Support the integrated conservation and sustainable use of biodiversity for food and agriculture across sectors;**
   b. **Support the conservation and sustainable use of associated biodiversity;**
   c. **Address food security and nutrition with explicit reference to biodiversity for food and agriculture, associated biodiversity and/or wild foods;**
   d. **Address the maintenance of ecosystem services with explicit reference to biodiversity for food and, associated**

biodiversity and/or wild foods;

e. **Improve resilience and sustainability of production systems with explicit reference to biodiversity for food and agriculture, associated biodiversity and/or wild foods;**
f. **Support farmers, pastoralists, forest dwellers and fisher folk to adopt and maintain practices that strengthen the conservation and use of biodiversity for food and agriculture.**

India has an extensive body of constitutional provisions, laws and policies to promote conservation and sustainable use of biodiversity and natural resources. The Indian constitution clearly assigns responsibilities between the Union and State Governments on various subjects. India is a signatory to various internationalconventions and a treaty related to environmental protection and has also taken numerous initiatives towards their implementation. The most relevant national policies and legislation are the Biological Diversity Act of 2002, National Policy and Macrolevel Action strategy on Biodoversity of 1999, National Forest Policy of 1988, National Water Policy of 2002, National Environmental Policy (NEP) of 2006, Indian Forest Act of 1927 (and related state legislation), forest (Conservation) Act of 1980, Wildlife (Protection) Act of 1972, Environmental (Protection) Act of 1986, Schedule Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act of 2006, Environmental Impact Assessment Notification of 2006, Factories Act of 1948, Mines and Minerals (Development and Regulation) Act of 1957, Energy Conservation Act of 2001, Air (Prevention & Control of pollution) Act of 1981,Water (Prevention & Control of pollution) Act of 1974. One of the most significant recent legislative steps taken by the GoI has been the setting up of the National Green Tribunal (NGT). The NGT is a dedicated statutory environmental court with the mandate to deal with civil cases which have substantial relation to environment including biodiversity. The NGT Act was passed by Parliament in 2010 and the Tribunal became functional on October, 18, 2010. In addition, the Supreme Court of India has also played a significant role in the conservation of biodiversity. Under Article 32 and Article 226, the Supreme Court and the High Court have played a proactive role in the conservation of biodiversity. In 2013, the Supreme Court of India set up a 'Green Bench' to deal with environmental issues replacing the existing Forest Bench. The jurisprudence on biodiversity is continuously evolving in India.

Livestock:

I. National Dairy Plan- Phase-I
There are three key components of NDPP-I:
1. Productivity enhancement
2. Village based procurement systems
3. Project management and learning

II. National Livestock Mission
(a) Livestock Development
(b) Fodder and Feed Development
(c) Pig Development in North-Eastern Region
(d) Skill Development, Technology Transfer and Extension

III. National programme for Bovine Breeding

IV. National Programme for Dairy Development

V. Conservation of Threatened Breeds of Livestock during XI Five Year Plan

VI. Rashtiya Gokul Mission

VII. National Kamdhenu Breeding Centre

VIII. Livestock Insurance Scheme

IX. Registration of livestock and poultry breeds

X. Livestock Census

XI. National Gene bank

XII. National plan for action of AnGR

XIII. Livestock Health and Disease control

XIV. Fodder and Feed Development Scheme

XV. Breeding farms

XVI. Central Herd Registration Scheme

Indian Fisheries Act, 1897 (modified 1956)–This act highlights the conservation aspects and banned the use of explosives and poisoning of waters for the destruction of fish.

Indian Wildlife (Protection) Act, 1972 Under this act that marine protected areas (marine national parks/ sanctuaries/ biosphere reserves) are declared to safeguard and protect the aquatic ecosystems along with their resources.

The Environment (Protection) Act, 1986 – It is to protect and improve environmental quality, control and reduce pollution from all sources and prohibit or restrict the setting and or operation of any industrial facility on environmental grounds.

The Coastal Regulation Zone (CRZ), 1991 – This notification impose restrictions on setting up and expansion of industries, operations or processes etc., with in the CRZ (i.e., the coastal stretch influenced by tidal action in the landward side up to 500m from the high tide line (HTL) and the land between the low tide line(LTL) and the high tide line (HTL).

Biological Diversity Act, 2002 : It is to protect the biological diversity of India. It provides for the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and related matters.

The Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976 : Enacted to establish sovereignty over the Indian maritime zone. It paved the way for establishment of a 200 nautical mile Exclusive Economic Zone (EEZ)

The Coast guard Act, 1978 : It ensures national security of maritime zones, protection of national interests in such zones and safety at sea.

The Maritime Zones of India Act, 1981: This act was introduced to control activities of foreign fishing vessels within Indian Maritime Zone.

Coastal Aquaculture Authority Act, 2005 : The main objective of this authority is to regulate aquaculture activities in coastal areas, to ensure sustainable development without causing damage to the coastal environment.

67. **List up to 10 major policies, programmes and enabling frameworks in your country that enhance the application of an ecosystem approach or a landscape approach and that contain an explicit reference to biodiversity for food and agriculture, associated biodiversity and/or wild foods. Include a brief description of the policies, programmes and enabling frameworks together with any information on the extent of their application (production system and area) and observed effect. Where possible provide examples of best practices or lessons learned.**

Biodiversity plays a crucial role in functioning of the ecosystems on which human kind depends for food and fresh water, health, recreation and protection from natural disasters. Its loss also affects cultural and spiritual values that are integral to human well-being. Current trends in loss of biodiversity and environmental degradation can greatly reduce the capacity of ecosystems to provide these essential services. The poor, who tend to be most immediately dependent on them, would suffer first and most severely. At stake are the principal objectives outlined in the MDGs viz. food security, poverty eradication, environmental security and human health. Conservation of biodiversity at the national level requires inputs from several Ministries/ Departments at the Central and State Governments' levels thereby reiterating the need for mainstreaming of biodiversity concerns in development planning processes. The 20 Aichi Biodiversity targets cross-cut all sectors of the national economy and affect ecology and human well- being. The policies, programmes and projects of as many as 23 Ministries/Departments of the GoI, which are directly or indirectly related to biodiversity conservation are critical for achieving progress towards Aichi Biodiversity Targets.

Livestock

Briefly describe policies, programmes and enabling frameworks that meet the objectives described in questions 68 and 69. Consider the following discussion points in your responses, where information is available:

a) extent of implementation;
b) production systems involved;
c) the extent of use of biodiversity for agriculture;
d) lessons learned;

e) evidence of indicators of vulnerability that have decreased as a result of these efforts;
f) describe the value added of mainstreaming gender in programmes, policies and enabling frameworks, providing sex-disaggregated data where possible.

Indian Fisheries Act, 1897 (modified 1956)–This act highlights the conservation aspects and banned the use of explosives and poisoning of waters for the destruction of fish.

Indian Wildlife (Protection) Act, 1972 Under this act that marine protected areas (marine national parks/ sanctuaries/ biosphere reserves) are declared to safeguard and protect the aquatic ecosystems along with their resources.

The Environment (Protection) Act, 1986 – It is to protect and improve environmental quality, control and reduce pollution from all sources and prohibit or restrict the setting and or operation of any industrial facility on environmental grounds.

The Coastal Regulation Zone (CRZ), 1991 – This notification impose restrictions on setting up and expansion of industries, operations or processes etc., with in the CRZ (i.e., the coastal stretch influenced by tidal action in the landward side up to 500m from the high tide line (HTL) and the land between the low tide line(LTL) and the high tide line (HTL).

Biological Diversity Act, 2002 : It is to protect the biological diversity of India. It provides for the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and related matters.

The Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976 : Enacted to establish sovereignty over the Indian maritime zone. It paved the way for establishment of a 200 nautical mile Exclusive Economic Zone (EEZ)

The Coast guard Act, 1978 : It ensures national security of maritime zones, protection of national interests in such zones and safety at sea.

The Maritime Zones of India Act, 1981: This act was introduced to control activities of foreign fishing vessels within Indian Maritime Zone.

Coastal Aquaculture Authority Act, 2005 : The main objective of this authority is to regulate aquaculture activities in coastal areas, to ensure sustainable development without causing damage to the coastal environment.

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areas, to ensure sustainable development without causing damage to the coastal environment.

Briefly describe policies, programmes and enabling frameworks that meet the objectives described in questions 68 and 69. Consider the following discussion points in your responses, where information is available:

a. extent of implementation;
b. production systems involved;
c. the extent of use of biodiversity for agriculture;
d. lessons learned;
e. evidence of indicators of vulnerability that have decreased as a result of these efforts;
f. describe the value added of mainstreaming gender in programmes, policies and enabling frameworks, providing sex-disaggregated data where possible.

68. Describe up to 10 major policies, programmes and enabling frameworks in your country that embed the use of biodiversity for food and agriculture, including its different components, into disaster management and response.

The MoEF implements policies and programmes relating to conservation of the country's natural resources, including lakes and rivers, biodiversity, forests and wild life, ensuring the welfare of animals, plants and human beings along with prevention and abatement of pollution. 'Environmental Education, Awareness and Training' is a flagship scheme of the MoEF for enhancing the understanding of people at all levels about the relationships between human beings and the environment and to develop capabilities/skills to improve and protect the environment. Some of the initiatives of the MoEF are National Environment Awareness Campaign, National Green Corps Programme, Paryavaran Mitra (Friends of the Environment) Programme, Global Learning and Observations to Benefit the Environment. Environment Education in the School System (EESS) has been an outcome of India's National Policy on Education, 1986 and the Supreme Court ruling of 2003 that Environment Education (EE) should be a compulsory curricular component at all levels of education, starting2004-2005.

Livestock

1. Livestock Breeding Policy
2. Livestock Census
3. Feed and Fodder Development
4. Livestock Health Management
5. Livestock Credit and insurance
6. Livestock Breeding farms
7. Central herd registration scheme
8. National Agricultural Innovation Program (NAIP)
9. All India Coordinated Research projects/ Network projects (ICAR)
10. National Dairy Plan I

All the programs implemented in whole of the country under livestock and livestock and crop mixed production system. Productivity with reference to performance and products of different species and per capita availability has been increased significantly and improved the livelihood of the farmers.

69. Describe up to 10 major policies, programmes and enabling frameworks in your country that embed the use of biodiversity for food and agriculture, including its different components, into climate change adaptation and mitigation strategies and plans (NAPAs, NAPs, NAMAs, etc.).

In 1999, the GoI prepared the National Policy and Macrolevel Action Strategy on Biodiversity (MoEF 1999) through a consultative process. This document was a macro-level statement of policies and strategies needed for conservation and sustainable use of biological diversity. Thereafter, the MoEF implemented an externally-aided project, the NBSAP, from 2000 to 2004, under which a final technical report was prepared. In 2002, India also enacted the Biological Diversity Act. Following India's adoption of the NEP in 2006, the NBAP was prepared by updating the National Policy and Macrolevel Action Strategy on Biodiversity developed in 1999 (MoEF 1999) and by using the final technical report of the NBSA Pproject in order to achieve consonance between the NBAP and the NEP 2006. India's NBAP, formulated through a comprehensive interministerial process, was approved by GoI in 2008 (MoEF 2008).However in the light of SP 2011-2020 and the Aichi Biodiversity Targets, there is a need to update the NBAP in order toalign it to the former. Further, possibilities of leveraging substantial financial resources at the national level to implement India's NBAP in the light of SP 2011-2020 and the Aichi Biodiversity Targets also

needs to be explored. An imaginative update of the NBAP may also offer policy options to seek catalytic financing from international financing sources, including multilateral grant-providing institutions such as the GEF.
The broad action points of India's NBAP 2008 are (i) strengthening and integration of in situ, on-farm and ex situ conservation, (ii) augmentation of the natural resource base and its sustainable utilization, (iii) ensuring inter- and intra generational equity, (iv) regulation of introduction of invasive alien species and their management, (v) assessment of vulnerability and adaptation to climate change and desertification, (vi) integration of biodiversity concerns in economic and social development, (vii) pollution impacts, (viii) development and integration of biodiversity databases, (ix) strengthening the implementation of policy, legislative and administrative measures for biodiversity conservation and management, (x) building national capacities for biodiversity conservation and appropriate use of new technologies, (xi) valuation of goods and services provided by biodiversity and use of economic instruments in decision-making processes and (xii) international cooperation. The actionable points under each of these 12 broad action points are given in Appendix II. The broad action points in India's NBAP are generally aligned with the five Strategic Goals of SP 2011-2020 and the corresponding 20 Aichi Biodiversity

Livestock

1. National Innovation in Climate Resilient Agriculture (NICRA)

National Innovations on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR) launched in February, 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. The research on adaptation and mitigation covers crops, livestock, fisheries and natural resource management. The project consists of four components viz. Strategic Research, Technology Demonstration, Capacity Building and Sponsored/Competitive Grants. The project has following key features:

• Critical assessment of different crops/zones in the country for vulnerability to climatic stresses and extreme events, in particular, intra seasonal variability of rainfall
• Installation of the state-of-the-art equipment like flux towers for measurement of green house gases in large field areas to understand the impact of management practices and contribute data on emissions as national responsibility.
• Rapid and large scale screening of crop germplasm including wild relatives for drought and heat tolerance through phenomics platforms for quick identification of promising lines and early development and release of heat/drought tolerant varieties.
• Comprehensive field evaluation of new and emerging approaches of paddy cultivation like aerobic rice and SRI for their contribution to reduce the GHG emissions and water saving.
• Special attention to livestock and fishery sectors including aquaculture which have not received enough attention in climate change research in the past. In particular, the documentation of adaptive traits in indigenous breeds is the most useful step.
• Thorough understanding of crop-pest/pathogen relationship and emergence of new biotypes due to climate change.
• Simultaneous up-scaling of the outputs both through KVKs and the National Mission on Sustainable Agriculture for wider adoption by the farmers

So far the major outcomes of NICRA project are as follows:
• Selection of promising crop genotypes and livestock breeds with greater tolerance to climatic stress.
• Existing best bet practices for climate resilience demonstrated in 100 vulnerable districts.
• Infrastructure at key research institutes for climatic change research strengthened.
• Adequately trained scientific man power to take up climate change research in the country and empowered farmers to cope with climate variability.

Indian Fisheries Act, 1897 (modified 1956)–This act highlights the conservation aspects and banned the use of explosives and poisoning of waters for the destruction of fish.

Indian Wildlife (Protection) Act, 1972 Under this act that marine protected areas (marine national parks/ sanctuaries/ biosphere reserves) are declared to safeguard and protect the aquatic ecosystems along with their resources.

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70. **What arrangements are in place or foreseen in your country that help to ensure that the conservation of biodiversity for food and agriculture is taken into account in national planning and policy development of sectors other than agriculture (e.g. NBSAPs or infrastructure development such as transport or energy)?**

Biological Diversity Act 2002 and Rules 2004 are implemented for conservation of the biodiversity. State biodiversity boards in all the 29 states and National Agriculture Biodiversity Board also set up to ensure the conservation of biodiversity. India has declared 11 Marine Protected Areas (MAP), spanning 36000 sq. km. In-situ conservation is carried out by declaring the particular areas as a Marine Protected Areas (MPAs) by designating them as National Parks or Wild life Sanctuaries or Biosphere Reserves. Marine Protected Areas not only protects the depleted, threatened, rare or endangered species and populations, but also their habitats. In India, there are four important National Marine Parks, three important Marine Sanctuaries and four important Biosphere Reserves to protect marine ecosystems with their resources.

Livestock

(i) National Biogas and Manure Management Programme (NBMMP)
Government of India Ministry of New and Renewable Energy (Biogas Technology Development Division) running a program for setting up of Family Type Biogas Plants mainly for rural and semi-urban/households. A family type biogas plant generates biogas from organic substances such as cattle –dung, and other bio-degradable materials such as biomass from farms, gardens, kitchens and night soil wastes etc. The process of biogas generation is called anaerobic digestion (AD) and salient benefits of biogas technology are given below-
(i) It provides clean gaseous fuel for cooking and lighting.
(ii) (Digested slurry from biogas plants is used as enriched bio-manure to supplement the use of chemical fertilizers.
(iii) It improves sanitation in villages and semi -urban areas by linking sanitary toilets with biogas plants.
(iv) Biogas Plants help in reducing the causes of climate change.
(ii) North Eastern Centre for Ethno Medical Research
Ministry of Science and Technology, Govt. of India has establishment an Ethno Medicinal Research Centre in Manipur with budgetary support of approx. Rs.6.00 crores has been approved. This Centre aims to undertake ethno phyto-chemical research of wild herbs available in the NE region that have unique medicinal and aromatic properties, particularly in our traditional systems. The Centre will enable scientific validation of traditional herbs and help improve quality of life and economic status of local community through product development.

71. **Has your country identified any obstacles to developing and implementing legislation that would protect associated biodiversity? List and describe initiatives in Table 25.**

Table 25. Obstacles to developing and implementing legislation that would protect associated biodiversity identified in the country.

Component of associated biodiversity	Obstacles to legislation for protection of associated biodiversity
Fishes	Large ecosystems, Lack of education

Add row

Delete row

Provide a concise description of the obstacles to legislation reported in Table 25, and specify a course of action proposed to address this, where possible. Where possible provide examples of best practices or lessons learned.

India harbours large amount of fish diversity in sea and inland waters but due to the vast area many times implementation of legislation is not possible. People are not adequately aware of the rules and regulations and many times even if knowledge is imparted they are not ready to accept. Most of the time people see short gain over the long term conservation.

Policies, programmes and enabling frameworks governing exchange, access and benefits

72. **Has your country taken measures with the aim of ensuring that access to its genetic resources shall be subject to its prior informed consent (PIC) and that benefits arising from their utilization shall be shared in a fair and equitable manner? If yes, identify for which resources and for which uses (e.g. to conduct research and development on the genetic and/ or biochemical composition of the genetic resource) prior informed consent has to be obtained and benefits have to be shared. Indicate in Table 26 for the different categories (and possibly uses) of associated biodiversity, if prior informed consent has to be obtained and benefits have to be shared.**

Table 26. Policies and programmes governing the access to its genetic resources of associated biodiversity established in the country.

Component of associated biodiversity	Intended use (e.g. any use, research and development, commercial use)	PIC and benefit-sharing required (Y/N)
Bio- resources	For commercial or research purposes or for the purposes of bio-survey and bio-utilisation.	Y
Associated Knowledge	For commercial or research purposes or for the purposes of bio-survey and bio-utilisation.	Y
Insect Resources	Research and Development, Commercial use	Y
Fishes	Research and development, commercial uses	Y

Add row

Delete row

73. **Has your country taken measures with the aim of ensuring that the prior informed consent or approval and involvement of indigenous and local communities is obtained for access to genetic resources and that benefits arising from the utilization of genetic resources that are held by indigenous and local communities, are shared in a fair and equitable way with the communities concerned, based on mutually agreed terms? If yes, provide a description of the measures and where possible, examples of best practices or lessons learned.**

Biological Diversity Act, 2002 covers conservation, use of biological resources and associated knowledge occurring in India It provides a framework for access to biological resources and sharing the benefits arising out of such access and use. The Act also includes in its ambit the transfer of research results and application for intellectual property rights (IPRs) relating to Indian biological resources.
The Act covers foreigners, non-resident Indians, body corporate, association or organization that is either not incorporated in India or incorporated in India with non-Indian participation in its share capital or management. These individuals or entities require the approval of the National Biodiversity Authority when they use biological resources and associated knowledge occurring in India for commercial or research purposes or for the purposes of bio-survey or bio-utilisation.

The National Biodiversity Authority (NBA) was established in 2003 to implement India's Biological Diversity Act (2002). The NBA is a Statutory, Autonomous Body and it performs facilitative, regulatory and advisory function for the Government of India on issues of conservation, sustainable use of biological resources and fair and equitable sharing of benefits arising out of the use of biological resources.

Biological Diversity Act 2002 and Rules 2004 ensures benefit and access to indigenous and local communities arising from the indegenous fishes used for value added commercial purposes.

Information management

74. List and describe any linkages between sector information systems on biodiversity for food and agriculture at national level. Where possible provide examples of best practices or lessons learned.

The State Biodiversity Boards (SBBs) focus on advising the State Governments, subject to any guidelines issued by the Central Government, on matters relating to the conservation of biodiversity, sustainable use of its components and equitable sharing of the benefits arising out of the utilization of biological resources;

Livestock

• Department of Agriculture, Animal Husbandry, Dairying and Fisheries (DADF: www.dahd.nic.in)
• Department of Agricultural Research and Education(www.dare.org.in)
• National Dairy development Boards (NDDB: www.nddb.org)
• National Bank for Agriculture and Rural Development (NABARD)
• NGOs
• National Biodiversity Authority, Chennai

Genetic improvement programs on different species especially cattle and buffalo for enhancement of milk productivity are going on in different parts of the country by different organisations (DARE, NDDB, NABARD, DADFand different NGOs) on different breeds in different parts of the country. Productivity of different livestock and poultry products and per capita availability has been increased significantly in last 10 years.

Different databases on fishes of India and conservation are developed at ICAR-NBFGR, Lucknow which includes, Indian fish information system, Fish Barcode Information System,Fish karyome,Fish MicroSAT, Ornamental fish database and National repository of fish cell line.

75. **Has your country established national information systems on associated biodiversity? List in Table 27, along with a description of the components of associated biodiversity addressed, and a brief description of information included, use and applications of the information system.**

Table 27. National information systems on associated biodiversity in the Country.

National information system (List)	Components of associated biodiversity addressed (List)	Concise description of information systems
Peoples Biodiversity Registers (PBRs)	Availability and knowledge of local biological resources, their medicinal or any other use or associated traditional knowledge	Local level Biodiversity Management Committees prepare PBRs. NBA and SBB provide guidance and technical support
NISM-GPA	genetic resources of all plant species with potential for food and agriculture, in situ management and development, ex situ conservation, utilization and institution and capacity building within the framework of the GPA	NISM is based on a list of internationally agreed indicators related to 20 GPA priority activity areas through computerized system for gathering and sharing information at national and international levels. The project works with the national partners and collaborates with regional and international organizations, especially Biodiversity International and other Consultative Group on International Agricultural Research Centres and networks in the region.
PGR Portal	Plant Genetic Resources	Information on available accessions in national gene bank, NBPGR
Indian Fish Information System (IFIS)	Fish	All the species of fishes available in India is available in this system
Ornamental fish database	Ornamental fishes	All the species of fishes which are having ornamental value is available in this system
Fish-Barcode Information system	gene sequence (COI)	Information regarding the sequences of cytochrome oxidase I of fishes is available in the system

National information system (List)	Components of associated biodiversity addressed (List)	Concise description of information systems
Fish Microsat	Microsatellite	Information regarding the microsatellite data of fishes is available in the system

Add row

Delete row

76. Has your country established information systems intended to support maintenance of traditional knowledge on biodiversity for food and agriculture, including associated biodiversity? If yes, describe these and include information where available on socio-economic, policy and collective action aspects.

In the Indian context especially, a range of socio-cultural values are derived from biodiversity that are philosophical, cultural and religious. Biodiversity and ecosystem diversity are reflected in the cultural and religious diversity of India through the varied values attached to biodiversity components and landscapes. India's many traditional knowledge systems and ethnomedicinal practices are based on a close understanding of and dependence on biodiversity. The cultural or religious importance of species and designation of sacred areas are well-known in India. The socio-cultural as well as aesthetic values attached to species and landscapes are reflected not only in the age-old tradition of sacred groves but also through formal designation of natural heritage sites which are most often also sites of significant local, regional or national cultural heritage.

India is rich in traditional knowledge associated with biological resources. This traditional knowledge is both coded, as in the texts of Indian systems of medicine such as Ayurveda, Unani and Siddha; and non-coded, which exists in the oral undocumented traditions. There is a separate Department in the Government, AYUSH that deals with developing and propagating

Homeopathy which have been making significant contributions towards the health care of the people. As on date, 6560 species of Indian medicinal plants have been recorded across these codified systems as well as folk traditions of health practices across 4635 ethnic communities of the country. Issues relating to protection of traditional knowledge though quite complex are of particular interest to India. Several attempts have been made for protection of traditional knowledge in the country. Some of the efforts to record traditional
use of biological resources are given below:

'The Wealth of India' series, one of the exhaustive scientific pursuits prepared by the CSIR, is an encyclopedia series on India's raw material resources of plants, animals and minerals. It consists of eleven volumes and two supplements.
The All India Coordinated Research Project on Ethnobiology of the MoEF launched in 1982 has unearthed a large spectrum of uses that tribal populations of the country make of plants and animals. The project has recorded use of over 10,000 wild plants known to tribals for varied purposes from across the country.
BSI and ZSI, responsible agencies for the survey and inventorization of flora and fauna of the country, have covered about 70% of the territory of India by field survey and published over the years, documents on flora and fauna at national, State and, in some cases, district level and for selected ecosystems. The surveys have also published Red Data Books on endangered species.
BMCs have been setup under Biological Diversity Act for conservation, sustainable use and documentation of biodiversity and chronicling traditional knowledge. This is also in line with constitutional amendment number 73 of 1993 that enshrines democratic decentralization of responsibilities, wherein local bodies consisting of elected representatives, one third of whom are women, are entrusted with the responsibility of safeguarding local environmental capacity stocks. So far 32,210 BMCs have been constituted by local bodies in 23 States (nbaindia.org).
The Biological Diversity Act mandates preparation of PBRs by the BMCs involving local people with guidance from SBBs and NBA, for documenting traditional knowledge relating to biodiversity. Though, the preparation of PBRs across the country is an enormous task, the programme is being implanted in a phased manner. A total of 1901 PBRs have been
registered in 14 States.

The Patent Act, 1970, provides for mandatory disclosure of source and geographical origin of biological material in the specifications when used for an invention. Non-disclosure or wrongful disclosure of the source of biological material and any associated knowledge results in refusal to the grant of patent or revocation of the patent.
The Protection of Plant Varieties and Farmers Right's (PPV&FR) Act provides for an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants. The Act recognizes the necessity of protecting the rights of farmers in respect of their contribution made in conserving, improving and making available plant genetic resources for the development of new plant varieties.

The Traditional Knowledge Digital Library (TKDL) database is a value added digital database developed by the GoI for (i) preservation of traditional knowledge; (ii) prevention of misappropriation of traditional knowledge by breaking the language and

format barriers of traditional knowledge systems, and providing access of these knowledge systems to patent

Livestock

• Knowledge based resource information systems hub for innovations in agriculture (Krishi) portal: “Krishi” is an initiative of Indian Council of Agricultural Research (ICAR) to bring its knowledge resources to all stakeholders at one place. The portal is being developed as a centralized data repository system of ICAR consisting of Technology, Data generated through Experiments/ Surveys/ Observational studies, Geo-spatial data, Publications, Learning Resources etc. It comprises different information systems- AICRPs and Network Projects, Bioinformatics resources, databases, genetic resources portals, technology and knowledge resources along with other portals important to farmers, researchers and other stake holders.
• Traditional Knowledge Digital Library (TKDL), a digital repository of traditional knowledge especially about medicinal plants and formulations used in Indian systems of medicine, set up in 2001 as a collaborative effort between the Council of Scientific and Industrial Research (CSIR) and Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (Dept. of AYUSH), Ministry of Health & Family Welfare, Government of India.
• Biodiversity information system (BIS) has been created by the Department of Biotechnology and the Department of Space.
• The ICAR maintains databases under the National Information Sharing Mechanism on the implementation of the Global Plan of Action (NISM-GPA) for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, which is a regional cooperative project of FAO in the Asia Pacific region.

Stakeholder participation and ongoing activities that support maintenance of biodiversity for food and agriculture

77. **List the most important stakeholder groups, including groups or associations of farmers, forest dwellers, fisher folk and pastoralists, NGOs or other civil society organizations active in the conservation of biodiversity for food and agriculture. Briefly summarize their scope, objectives and activities and any outcomes to date. Where possible provide examples of best practices or lessons learned.**

Crops

1. M. S. Swaminathan Research Foundation (MSSRF) aims to accelerate use of modern science for agricultural and rural development for development and dissemination of technology to improve lives and livelihoods of tribal and rural communities. MSSRF follows a pro-poor, pro-women and pro-nature approach and applies appropriate science and technology options to address practical problems faced by rural populations in agriculture, food and nutrition in a participatory manner. the Foundation has made its impact felt in various dimensions making a difference to the lives of over 600,000 individuals, impacting livelihood of 100,000 farmers and fisherfolk. .
MSSRF is carrying out research and development in six major thematic areas, besides special projects and cross-cutting areas and themes:Coastal Systems Research, Biodiversity, Biotechnology, Ecotechnology , Food Security, Information, Education and Communication, Grass Root Institutions.

2. A NGO named Community Empowerment Organization for Rural Development (CEORD) at Banikhet (Chamba) with technical backstopping of Himachal Pradesh Mid-Himalayan Watershed Development Project, Watershed Division, Bhatiyat at Chowari (Chamba).

3. Village level Community Seed Banks, for distribution among farmers. Sixteen community seed banks (CSBs) have been established in Udaipur district covering all three project intervention clusters

Livestock

i. Breed Societies
Breed societies are taking care of purebred animals registration, their breeding and management. Breeding societies for Sahiwal, Ongole, Deoni and Binjharpuri cattle, Banni and Chilka buffaloes, Kathiawari and Marwari horses, Kharai and Kachhi camel established.

ii. Non Government Organizations (NGOs)
NGOs are working on characterisation, conservation and genetic improvement of different breeds of livestock in their breeding areas and played significant role in enhancement of productivity. Some of the NGOs working on livestock and poultry are SEVA, LPPS, BAIF, ANTHRA, SEHJIVAN and SURE.

iii. Scientific Organisations
There are some scientific organisations those are working on AnGR as given below.
NDDB Working on the dairy development in India

NABARD working as a financial institution for rural development

Fishing in many reservoirs and rivers in India is managed by co-operative societies and self help groups.

78. **Describe any incentives or benefits to support activities for the conservation and sustainable use of biodiversity for food and agriculture or associated biodiversity (such as payments, provision of inputs, subsidies or other forms of incentives/ benefits). Briefly describe how these have been applied, to what extent and the stakeholders involved (including provisions on gender balance if any). Indicate any lessons learned and planned development incentives.**

Plants
The Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA) has been established by the Central Government under the Protection of Plant Varieties and Farmers' Rights Act, 2001. The Authority grants exclusive rights to the breeders and farmers who have bred, evolved or developed any variety. The Protection of Plant Varieties & Farmers' Rights Authority, under the provision of section 45 of PPV&FR Act, 2001 Rule 70 (2) (a) [PPV&FR Rules, 2003] has instituted Plant Genome Savior Community Award. Additionally, as per section 39 (1)(iii) of PPV&FR Act, 2001, the Central Government has notified the PPV&FR (Recognition and Reward from the Gene Fund) Rules, 2012 for rewarding and recognizing farmers.
The Authority confers the "Plant Genome Savior Community Award" annually on the basis of shortlisting and site verification of the applications received from the community of farmers/farming community based organizations who have a long track record for conserving plant agro-biodiversity.There are maximum of five awards in a year, consisting of a cash of Rs.Ten lakh each, a citation and a memento.

"Plant Genome Savior "Farmer Reward" & "Farmer Recognition" from the farmers engaged in the conservation of genetic resources of landraces and wild relatives of economic plants and their improvement through selection and preservation and the material so selected and preserved has been used as donors of gene in varieties registerable under the PPV&FR Act, 2001 (53 of 2001). There are maximum of 10 rewards (comprising of citation, memento and cash of Rs.One lakh each) and 20 recognitions (consisting of a citation and memento) in a year.

Livestock
• There is no direct subsidy to the stakeholders, while some improved germplasm is distributed to the framers for improvement and conservation of endangered/important breeds like Krishna Valley, Cattle, Beetal goat and Killakarsal sheep.
• Haryana state Government providing incentives to the farmers for elite germplasm based on daily milk production of Murrah buffalo and Hariana and Sahiwal cattle in the state.
• Breed Savoir Awards

Breed Saviour Awards are organised by Sustainable Agriculture & Environment Voluntary Action (SEVA), Madurai in association with Honey Bee Network members and National Bureau of Animal Genetic Resources, Karnal and sponsored by the National Biodiversity Authority, Chennai. Awards are given to 20-25 livestock keepers every year for their significant contribution towards to conservation of animal genetic resources in India. In the year 2013 , a total of 21 have livestock keepers have been selected for the award . This includes 6 breeds of sheep, 4 goat breeds, 3 breeds of cattle and a breed each of a duck, buffalo, dog and pig from 6 different states namely Karnataka, Kerala, Odisha, Punjab, Rajasthan and Tamil Nadu. In the year 2015 20 applications of different parts of the country have been received and 8 were awarded.

During closed season, government agencies provide financial assistance to registered fisher-folks to compensate for loss of their livelihood.

79. List up to 10 major projects (either in progress or completed in the last five years) that support the conservation and sustainable use of biodiversity for food and agriculture, associated biodiversity and/or wild foods. For each project listed describe the components of biodiversity, the production system and area covered, and the results, outcomes and lessons learned. Projects described in sector reports need not be described here.

Plants
1. Assessment and data collection on bio-resources of agriculture and forestry for three watersheds in Himachal Pradesh for creating BIO-GEO DATA BASE for ecological modeling of Himalaya – a multi-institutional project
2. Germplasm exploration, collection, characterization, evaluation and documentation of agri-horticultural crops of Himachal Pradesh and Jammu & Kashmir – a multi-institutional project
3. Ex-situ conservation and rare and endangered plant species of N-W Indian Himalayas in the Botanic Garden
4. On farm conservation and promotion of cultivation of small millets, pseudo-cereals and landraces in participatory mode in Himachal Pradesh
5. Biotechnological Approach for Cryo-preservation of Apple Germplasm using Winter Buds
6. Harmonizing biodiversity conservation and agricultural intensification through integration of plant, animal and fish genetic resources for livelihood security in fragile ecosystems
7. Collection, Mapping, Evaluation and Conservation for sustainable Utilization of Plant Genetic Resources of Cold Desert

Region of India.
8. Mainstreaming farmer's varieties in the Western Mid Himalayan region of India.
9. Mainstreaming agricultural biodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability

Livestock
1. Conservation of threatened breeds (endangered breeds of livestock and poultry)
2. All India Coordinated Research projects (cattle, buffalo, sheep, goat, pig and poultry)
3. Network projects (different breeds of livestock and poultry)
4. Mega Seed projects (Sheep and pig)
5. National project for cattle and buffalo breeding (NPCBB)
6. Rashtiya Gokul Mission
7. Registration of livestock and poultry breeds
8. Breed Savior Awards
9. National plan for action of AnGR
10. National Kamdhenu Breeding centre
The listed projects are going on and covered important breeds of livestock and poultry for their genetic improvement and conservation covering whole of the country. Projects are helpful in characterisation and registration of new germplasm/breeds, enhancement of productivity of different livestock products.

Insects
1. ICAR Network project Insect Bio-Systematics
2. All India Co-ordinated Project on Biological Control of Crop Pests

Microbes

1. ICAR Network project on Application of Microorganisms in Agriculture and Allied Sectors
2. All India Network project on Biofertilizers (ICAR)
3. Diversity of Bacillus and other predominant genera in extreme environments and its utilization in agriculture and allied sectors (NAIP, ICAR)
4. Role of archaea in alleviation of salinity and moisture stress in plant (NASF, ICAR)

Fisheries

Harmonizing biodiversity conservation and agricultural intensification through integaration of plant, animal and fish genetic resources for livelihood security in fragile ecosystem.
ICAR-CRP on Agrobiodiversity: National network on Agrobiodiversity management

80. **List in Table 28 up to 10 major landscape based initiatives to protect or recognize areas of land and water in your country of particular significance for biodiversity for food and agriculture.**

Table 28. Landscape based initiatives to protect or recognize areas of land and water in the country with particular significance for biodiversity for food and agriculture.

Landscape based initiatives	Description of sites and their characteristics of relevance to biodiversity for food and agriculture	Extent (area)
Nilgiri Biosphere Reserve	Part of Wynad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani hills in Tamil Nadu, Kerala and Karnataka	5520 sq. km
Nanda Devi Biosphere Reserve	Part of Chamoli, Pithoragarh and Almora districts in Uttarakhand	5860.69 sq. km
Nokrek Biosphere Reserve	Part of East, West and South Garo Hill districts in Meghalaya.	820 sq. km
Sunderban Biosphere Reserve	Part of delta of Ganges &Brahamaputra river system in West Bengal.	9630 sq. km
Gulf of Mannar Biosphere Reserve	India part of Gulf of Mannar extending from Rameswaram island in the North to Kanyakumari in the South of Tamil Nadu.	10500 sq. km
Great Nicobar Biosphere Reserve	Southern most island of Andaman and Nicobar Islands.	885 sq. km

Landscape based initiatives	Description of sites and their characteristics of relevance to biodiversity for food and agriculture	Extent (area)
Similipal Biosphere Reserve	Part of Mayurbhanj district in Orissa.	4374 sq. km
Dibru-Saikhova Biosphere Reserve	Part of Dibrugarh and Tinsukia districts in Assam.	765 sq. km
Dehang-Dibang Biosphere Reserve	Part of Upper Siang, West Siang and Dibang Valley districts in Arunachal Pradesh.	5111.5 sq. km
Pachmarhi Biosphere Reserve	Part of Betul, Hoshangabad and Chhindwara districts in Madhya Pradesh	4981.72 sq. km
Khangchendzonga Biosphere Reserve	Part of North and West districts in Sikkim	2931.12 sq. km
Agasthyamalai Biosphere Reserve	Part of Thirunelveli and Kanyakumari districts in Tamil Nadu and Thiruvanthapuram, Kollam and Pathanmthitta districts in Kerala.	3500.36 sq. km
Achanakmar- Amarkantak Biosphere Reserve	Part of Anuppur and Dindori districts of Madhya Pradesh and Bilaspur district of Chattisgarh.	3835.51 sq. km
Kachchh Biosphere Reserve	Part of Kachchh, Rajkot, Surendranagar and Patan districts in Gujarat.	12454 sq. km
Cold Desert Biosphere Reserve	Pin Valley National Park and surroundings Chandratal& Sarchu; and Kibber Wildlife sanctuary in Himachal Pradesh	7770 sq. km
SeshachalamBiosphere Reserve	Seshachalam hill ranges in Eastern Ghats encompassing part of Chittoor and Kadapa districts in Andhra Pradesh	4755.997 sq. km
Panna Biosphere Reserve	Part of Panna and Chhattarpur districts in Madhya Pradesh	2998.98 sq. km
National Wetland Conservation Programme (NWCP),	In closed collaboration with concerned State Government. Under the programme 115 wetlands have been identified till now by the Ministry which requires urgent conservation and management initiatives.	
Ramsar Convention on Wetland	The Ramsar Convention on Wetlands was developed as a means to call international attention to the rate at which wetland habitats were disappearing, in part due to a lack of understanding of their important functions, values, goods and services. Governments that join the Convention are expressing their willingness to make a commitment to helping to reverse that history of wetland loss and degradation	
Salim Ali Centre for Ornithology and Natural History (SACON)	SACON commenced functioning in 1992, and is situated at Anaikatty, Coimbatore, Tamil Nadu. SACON has undertaken 174 Research and Environment Assessment Projects with a financial value of approximately 12 crores	

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Collaboration between institutions and organizations

81. **Describe existing linkages and collaboration between sectors in national programmes and policies governing conservation and sustainable use of biodiversity for food and agriculture. These may include overall strategies and plans developed by your country, committees or other national bodies which oversee or support collaboration, shared actions, facilities or resources and specific activities which involve inter-sector collaboration.**

(i) Harmonizing Biodiversity conservation and Agricultural Intensification through Integration of plant Animal and fish genetic resources for livelihood security in fragile ecosystem (NAIP)

The project was started in 2009 under NAIP and completed in the year 2013. Silent achievements are as follows-

a. Revival of elite local crop landraces, animal breeds and fish resources
• Characterization of local animal breeds and identification of elite strains of local cattle, gaddi sheep and goat in Chamba; Gir cow, Surti buffaloes, Sirohi goats and Sonadi sheep in Udaipur, and cow (Ponganur, Ongole, Red Kandhari), buffalo (Surti

type), goat (Osmanabadi, Konkan Kanyal, Jamunapari) and sheep (Nellore) in Adilabad for distribution among farmers have been duly addressed.
• The local crop landraces viz. red rice, rajmash and maize (popping and sugary type) in Chamba; maize (Malan and Sathi), sorghum (Desi jowari) and redgram in Udaipur, and scented rice (Chittimuthyallu), sorghum, red gram, green gram and black gram in Adilabad have the proven potential for bringing sustainability in production systems. The elite strains have been identified and duly included in the local seed chain for bringing more area under cultivation and enhanced production.
• Identified major native cultivable fish species and their potential areas for captive propagation and their utilization in raising brood stock in selected District: Adilabad (A.P.) - Labeo fimbriatus (Chitra rohu), L. calbasu, L. dero and L. dyochielus Udaipur (Raj.) - L. gonius Labeo sp. and L. boggut Chamba (H.P.) - Scizothorax richardsonii.
• First record of extended distribution of a fish species Tor tor in the peninsular region of India (from Adilabad district of Andhra Pradesh).
• First baseline data documented on length-weight relationships and condition factor of Indian snow trout Schizothorax richardsonii from river Ravi and its tributaries of District Chamba.

b. Exploring various “adding value” interventions to local resources for livelihood security of local farmers

• Local crop and animal breed improvement efforts through strengthening the local seed network for the elite landraces and identification of elite local breeds for distribution among local farmers in all three districts have started creating desired impact. Farmers have been greatly benefited participating in these interventions. More than 50q seed of local landraces is currently available for distribution among farmers in local seed chain.
• Efforts to register the local landraces with PPV&FR Authority and characterization and subsequent registration of non-descript animal breeds, as also the development of CBRs/PBRs have been helpful in farmer empowerment and their IPR protection. Community Gene banks have been created in almost all project intervention sites.
• Elite strains of established animal breeds and elite strains of local non-descript breeds have been distributed to farmers for breed improvement.
• The potential of local fish fauna for livelihood security of farmers including potential of ornamental fish farming is being worked out.
• “Adding value” to plant, animal and fish products through packaging, processing and organic farming has great marketing potential to local resources fetching premium price in local and distant markets.
• Besides, several other interventions including health, nutrition and improved housing management of livestock; integration of fisheries interventions with vermi-compost and poultry; rain-water harvesting structures (e.g. farm pond technology of Adilabad) are in operation and adding value to local resources.
• About 3,000 farm households are involved in various project interventions in all three districts and carrying capacity of the farm sector is being worked out. Exploring the best use of locally available crop, animal and fisheries resources for economic development of local farmers is currently underway.

(ii) NICRA (details are give in question 69)

Collaborating with National Biodiversity Authority (NBA) for conserving biodiversity. Established National Agriculture Biodiversity Board and State Agriculture Biodiversity Board.

82. **How are ministries working together to meet Aichi Targets as they may apply to the conservation and sustainable use of biodiversity for food and agriculture in your country?**

NBA, (Ministry of Environment and Forest) collaborate with DARE under Ministry of Agriculture and farmers welfare on issues related to Agrobiodiversity including FGR. Organisations like NBFGR and CMFRI are recognised for repositories by NBA for the purpose of fish genetic resource exchange.

83. **What future actions have been planned to support your country's efforts in addressing Aichi Targets as they may apply to the conservation and sustainable use of biodiversity for food and agriculture in your country?**

In situ and ex-situ conservation of genetic resources, knowledge development on the genetic diversity and taxonomic validation, establishment of germplasm repository, evaluation of exotic species, guidelines for safe introduction of exotic species.

84. **Is your country involved in the implementation of regional and/or international initiatives targeting the conservation and sustainable use of associated biodiversity? List initiatives in Table 29.**

Table 29. Regional and/or international initiatives targeting the conservation and sustainable use of associated biodiversity.

Initiatives	Scope (R: regional, I: international)	Description	References
Linkages among the Insect collection in the country	R	a network of insect collections in the country already exists	
Linkages among the culture collection in the country	R	Attempt were made to develop a network of culture collections in the country.	
Linkages with WFCC	I	NAIMCC (ICAR-NBAIM) is recognized by the WFCC.	
CBD	I	India is signatory to CBD which aim for conservation of biodiversity for sustainable use	
CITES	I	India is signatory to CITES which aim for restriction of trade in endangered species	
UNCLOS	I	India is signatory to UNCLOS which defines the rights and responsibilities of fishing in the seas	
CCRF	I	Code of Conduct of responsible fishing (CCRF) aim to sustainable fisheries in the area	

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Capacity development

85. **What training and extension programmes, or elements of programmes, at all levels, exist that target the conservation and sustainable use of associated biodiversity?**

Under the NAIP (GEF) Sub-project titled "Harmonizing biodiversity conservation and agricultural intensification through integration of plant, animal and fish genetic resources for livelihood security in fragile ecosystems" executed in three disadvantaged districts, Chamba in Himachal Pradesh, representing the Hill and Mountain agro-ecosystem; Udaipur in Rajasthan (Irrigated and rainfed agro-ecosystem in Arawali hills with semi-arid climate), and Adilabad in Andhra Pradesh (Deccan Plateau and Sahyadri Hills with subtropical climate)
Targeted Strengthening local seed system through Community Seed Banks (CSBs).
Lack of community level seed networks has been the most important factors primarily responsible for loss of landrace diversity under subsistence small-holder farming. Strengthening local seed exchange networks and linking farmers' seed supply to the formal sector could serve to broaden farmers' option regarding variety choice while fostering diversity conservation.
Incorporation of landraces into agricultural extension packages and training extension personnel to recognize the importance of local landraces for conservation and local livelihood security is, however, considered essential. Capacity building in agro-biodiversity management for livelihood security through organization of the grassroots level trainings for awareness generation on agro-biodiversity conservation and use,providing post-harvest management and marketing support for agriculture, livestock and fisheries through creation of self-help and community level farmer cooperatives was taken up under the project.

The potential methods for "adding benefits" for farmers integrating plant, animal and fish genetic diversity,are associated with the maintenance of high genetic diversity over time and general means of enhancing the benefits to farmers, included improving the landrace material and production system (through farmers' participation, strengthening farmers' seed management, agro-ecosystem health, etc.), increasing farmers' access to a diversity of varieties (community biodiversity registers and community seed banks, seed exchange networks,linking farmers' seed supply systems to the formal sector, incorporating local crop resources into agricultural extension packages, diversity fairs, etc.), and increasing consumer demand for products using a diversity of varieties (adding value through processing, organic farming, etc.) under the project

Training programs are conducted on the Conservation and utilization of insect biocontrol agents by different Institutes, State Agricultural Universities and Central Universities.

Training programs were conducted on the Conservation and utilization of microorganisms by different Institutes, State Agricultural Universities and Central Universities.

Several extension activities including mass awareness programmes, short-term trainings, demonstration and ranching programmes, exhibitions, public lectures, media interactions, etc. are organised for promoting and facilitating conservation of aquatic biodiversity by different organizations like research institution, universities, state fisheries departments, non-government organizations across the country.

86. **What higher education programmes exist that target the conservation and sustainable use of associated biodiversity genetic resources? List in Table 30 the institutions, as well as the programmes and enrolment, disaggregated by sex, if possible**.

Table 30. Higher education programmes specifically targeting the conservation and sustainable use of associated biodiversity genetic resources in the country.

Institution	Programme	Level	Enrolment (total)	Enrolment (male)	Enrolment (female)
Post graduate school, Indian Agricultural Research Institute	Plant Genetic Resources	MSc	52	42	10
Post graduate school, Indian Agricultural Research Institute	Plant Genetic Resources	PhD	14	11	3
ICAR-Central Institute of Fisheries Education, Mumbai	Master of Fisheries Science	Masters	75		
ICAR-Central Institute of Fisheries Education, Mumbai	Doctor of Philosophy	Doctoral	30		

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87. List up to 10 major institutions within your country directly involved in research on the conservation and sustainable use of associated biodiversity. Provide a concise description of the institutions, of their key research programmes and, where possible, provide the number of active researchers.

1.ICAR- National Bureau of Plant Genetic Resources (ICAR-NBPGR)

• Management and promote sustainable use of plant genetic and genomic resources of agri-hotricultural crop and carry out related research
• Coordination and capacity building in PGR management and policy issues governing access and benefit sharing of their use
• To plan, organize, conduct and coordinate exploration and collection of indigenous and exotic plant genetic resources.
• To undertake introduction, exchange and quarantine of plant genetic resources.
•To characterize, evaluate, document and conserve crop genetic resources and promote their use, in collaboration with other national organizations.
•To develop information network on plant genetic resources.
•To conduct research, undertake teaching and training, develop guidelines and create public awareness on plant genetic resources.

2.ICAR- National Bureau of Animal Genetic Resources (ICAR-NBAGR)

• Identification, Evaluation, Characterization, Conservation and sustainable Utilization of Livestock and Poultry Genetic Resources.
• Coordination and capacity building in animal genetic resources management and policy issues.

3. ICAR- National Bureau of Agriculturally Important Microorganisms (ICAR-NBAIM).

To act as the nodal Institute at national level for acquisition and management of indigenous and exotic microbial genetic resources for food and agriculture, and to carry out related research and human resource development, for sustainable growth of agriculture".

Objectives:

1. Exploration and Collection of Agriculturally Important Microorganisms (AIMs)

2. Identification, characterization and documentation of AIMs
3. Conservation, maintenance and utilization of AIMs
4. Surveillance of indigenous/exotic AIMs
5. Microbial diversity and systematics
6. Human resource development

4. ICAR-National Bureau of Fish Genetic Resources (ICAR-NBFGR)

NBFGR established under the Indian Council of Agricultural Research, Ministry of Agriculture and Farmers Welfare, Govt. of India, has taken up various research programmes to generate empirical information relevant to conservation strategies of prioritized and endangered fish species. The Bureau undertakes germplasm exploration programmes in various aquatic ecosystems of the country and has built up a strong database on fish genetic resources of the country; generated information on population genetic structure and genomic resources of several aquatic species; developed techniques for ex situ gene banking of endangered species and diagnostic capabilities for exotic pathogens of aquatic organisms; and contributed significantly in bringing out several policy documents for the country.

5. ICAR-National Bureau of Agricultural Insect Resources (ICAR-NBAIR)

To act as a nodal agency for collection, characterization, documentation, conservation, exchange, research and utilization of agriculturally important insect resources(including mites, spiders and related arthropods) for sustainable agriculture.
Capacity building, dissemination of technologies and forging linkages with stake holders.
On farm validation of biocontrol strategies, forging linkages with commodity based crop research Institutes, AICRP/ AINP and capacity building.

6. ICAR- Indian Agricultural Research Institute (ICAR-IARI)

• Basic, strategic and anticipatory research in field and horticultural crops for enhanced productivity and quality.
• Research in frontier areas to develop resource use efficient integrated crop management technologies for sustainable agricultural production system.
• Serve as centre for academic excellence in the areas of post-graduate and human resources development in agricultural science.
• Provide national leadership in agricultural research, education, extension and technology assessment and transfer by developing new concepts and approaches and serving as a national referral point for quality and standards

7. CSIR-National Botanical Research Institute CSRI-(NBRI)

1. Botanic Garden and Distant Research Centers
2. Plant Diversity, Systematics and Herbarium
3. Plant Ecology & Environmental Science
4. Genetics and Molecular Biology
5. Plant Microbe Interaction & Pharmacognosy
6. S&T Support Services

8. Forest Research Institute

1. Conservation of biodiversity
2. Production, certification and supply of quality seedsof fuel, fodder and timber species.
3. Social forestry/ Agroforestry.
4. Conservation and eco-restoration of ecologically fragile and disturbed areas.
5. Utilisation of non-conventional woods and weeds for manufacture of forest products.
6. Development of technology for reclamation of wastelands.
7. Planting stock improvement programme of different species.

9. ICAR-Indian Veterinary Research Institute (ICAR-IVRI)

• To conduct research, provide postgraduate education and transfer of the technology in all areas of animal sciences with emphasis on animal health and production.
•To act as national referral centre for veterinary type cultures, disease diagnosis, biologicals, immunodiagnostics, etc.

10. Central Institute of Fisheries Technology (CIFT)

• Basic and strategic research in fishing and processing.
• Design and develop energy efficient fishing systems for responsible fishing and sustainable management

• Development of implements and machinery for fishing and fish processing.
• Human resource Development through training, education and extension.

Knowledge generation and science for the management and sustainable use of biodiversity for food and agriculture

88. **With respect to information management, national policies, programmes and enabling frameworks that support or influence the conservation and sustainable use of biodiversity for food and agriculture and the provision of ecosystem services, and govern exchange, access and benefits:**

a. What are the major gaps in information and knowledge?
b. What are the main capacity or resources limitations?
c. What are the main policy and institutional constraints?
d. What actions are required and what would be the priorities?

a) What are the major gaps in information and knowledge?
1. Inadequate legislation framework for livestock policy implementation, registration and protection of farm animal breeds and animal keepers' rights
2. Absence of designated National Focal Point for conservation and management of genetic resources
3. Lack of harmony and coordination between various institutions involved in management of genetic resources
4. Inadequate infrastructure facilities for national and regional gene banks with appropriate modalities for production, processing, cryostorage of germplasm and dissemination
5. Lack of policies and programmes for animal grazing in forest areas and development of pastures
6. Lack of awareness among livestock keepers and stakeholders regarding importance of conservation and utilization of diverse AnGR
7. Large gap between the knowledge of stakeholders and policy planners on scientific management
8. Large gap on access of the knowledge between stakeholders and policy planners
9. Gap in networking among the stakeholders, policy planners and technocrats.
10. Inadequate funding

b) What are the main capacity or resources limitations?
1. Lack of networking infrastructure
2. Inadequate funding
3. Inadequate trainers
4. Losing the interest by the stakeholders on livestock and poultry farming
5. Inadequate marketing facilities and their networking for livestock and their products

c) What are the main policy and institutional constraints?
1. Inadequate price policy, without farmers consents
2. Inadequate animal import and export regulations
3. Lack of proper regulations on livestock products sale and purchase

d) What actions are required and what would be the priorities?
1. Need for a comprehensive and farmer proactive national livestock policy, which should provide sound livelihood to Indian livestock keepers.
2. National policy on livestock population to limit the total number of animals in proportion to availability of resources. This will result in increased per capita input availability, thus leading to higher productivity.
3. A regulatory legal framework for implementation of breeding, feeding, housing, animal health management policies and field performance recording system for conservation and genetic enhancement of farm animal breeds.
4. A legislation act for protection of Animal Breeds and Animal Keeper's rights in line with Protection of Plant Variety and Farmers Right Act.
5. Defining roles and functions of agencies working for management of AnGR (ICAR, State & Central Animal Husbandry Departments, Livestock Development Boards, NBA, etc) to avoid overlapping and appropriate utilization of funds
6. Establish fully functional National Focal Point for animal genetic resources. The headquarters of the National focal point may be at NBAGR, Karnal.
7. Develop a cadre of professionals to support management of AnGR on long-term basis Include special courses on management and sustainable utilization of AnGR at graduate and post graduate levels of all the courses pertaining to Animal/ Veterinary Sciences.
8. Development of networking among the stakeholders, policy planners and technocrats.

Aquaculture
There are several databases on fish diversity of the country, however, there is need for establishing integration and synergy

among various repositories of information existing in the country. Wide range of policies and programmes are in place in the country to facilitate and support conservation and sustainable use of aquatic biodiversity.
Due to diverse and complex nature of the aquatic biodiversity available in the country across various ecosystems and geographical locations, availability of detailed and precise information on various aspects of availability, access and use of aquatic biodiversity is difficult and need further efforts to improve.

89. **With respect to stakeholder participation and ongoing activities that support maintenance of biodiversity for food and agriculture and collaboration between institutions and organizations:**

a. **What are the major gaps in information and knowledge?**
b. **What are the main capacity or resources limitations?**
c. **What are the main policy and institutional constraints?**
d. **What actions are required and what would be the priorities?**

a) Major gaps in information and knowledge
1. Inadequate programmes for identification, evaluation and selection of genetically superior genetic resources.
2. Absence of animal identification and performance recording system under field conditions.
3. Lack of awareness, participation and motivation of the livestock keepers regarding breed conservation and genetic improvement programmes.
4. Lack of coordination among various agencies involved in livestock improvement and conservation.
5. Inadequate infrastructure for A.I. and animal health support particularly for indigenous breed development programmes
6. Lack of scientific basis and validation of traditional knowledge regarding usefulness (nutritional or therapeutically) of animal genetic resource products.
7. Large gap on access of the knowledge between stakeholders and policy planners
8. Inadequate funding
9. Lack of harmony and coordination among different agencies.

b) Main capacity or resources limitations

1. In adequate training facilities
2. Trainers are not available in sufficient number
3. Poor marketing system for animals, animal products and by products.
4. Poor awareness about AnGR
5. Lack of scientific management skills
6. High population density vis-à-vis inadequate feed and fodder resources, and pasture land availability

c) Main policy and institutional constraints

1. Inadequate price policy, without farmers consents
2. Inadequate animal import and export regulations
3. Lack of proper regulations on livestock products sale and purchase
4. Lack of regulations on breeding of animals

d) Actions are required and what would be the priorities

1. Establishment and strengthening of nucleus farms in the breeding tract for each breed.
2. Formation of breed societies/associations will patronize the participation of livestock keepers in sustainable management and judicious utilization of indigenous breeds in the face of growing food demand and climate change.
3. Economic worth of the indigenous breeds should be enhanced through value addition by propagating environmentally important attributes of different animal breeds and useful pharmaceutical and nutritional properties of their animal products.
4. Developing branded animal product and creation of niche markets for such products.
5. ITKs related to management of AnGR need to be collected, evaluated, validated and commercially exploited to benefit the communities rearing these animals.
6. Creation of sufficient training facilities
7. Increase in numbers of trainers
8. Creation of awareness about AnGR in stakeholders
9. Adequate funding
10. Proper price policy, with farmers consents

Aquaculture
Mechanisms are in place to ensure participation of various stakeholders in planning and implementing the programmes for

sustainable use and maintenance of aquatic biodiversity. Initiatives undertaken to this end include representation of different stakeholders in policy framing, planning conservation programmes, assessing technologies; organising mass awareness programmes for enhancing knowledge and participation of stakeholders in conservation and management of aquatic biodiversity and several others.
There is need for capacity development of various types of stakeholders to take active part and contribute effectively in maintenance of aquatic resources, using existing mechanisms.

90. **With respect to capacity development:**
   a. **What are the major gaps in information and knowledge?**
   b. **What are the main capacity or resources limitations?**
   c. **What are the main policy and institutional constraints?**
   d. **What actions are required and what would be the priorities?**

a) Major gaps in information and knowledge
1. Gap of knowledge between trainers and stakeholders on livestock scientific management
2. Inadequate extension of technology to the stakeholders
3. Lack of local institutions like breed societies or herders groups/association.
4. Lack of IT infrastructure
5. Mostly livestock and poultry rearing is secondary occupation of most of the farmers in the country
6. Lack of harmony and coordination among different agencies.
b) Main capacity or resources limitations
India has vast infrastructure for management of AnGR. There exists a large network of central and state animal husbandry departments looking after the development of animal husbandry (health care, breeding and feeding) at the grass root level.
• Indian Council of Agricultural Research has Animal Science Division. In the division, there is a vast network of national institutes (National Dairy Research Institute, Indian Veterinary Research Institute) species specific institutes (CIRC,CIRB,CIRG,CSWRI) national research centre (NRCC,NRC on Yak, NRC on Mithun), bureau (NBAGR) and National Institute of Animal Nutrition & Physiology. The division has Project Directorates (2), AICRPs (17), Netwok projects, Mega Seed Projects for carrying out research for the improvement and management of various livestock genetic resources, processing of products, health care and to develop trained manpower.
• ICAR has also established National Bureau of Animal Genetic Resources with the mandate of identification, evaluation, characterization, conservation and utilization of livestock and poultry genetic resources.
• There are 75 (2016) Agricultural Universities in various states dealing specifically with the requirements and problems of the region and also producing trained manpower in veterinary and animal sciences.
• There are four veterinary universities imparting education and conducting research in animal husbandry sector.
• There is an extension network in the country in the form of Krishi Vigyan Kendras (692) for dissemination of information generated in different research organizations.
• There are large number of livestock/poultry farms (249 for cattle, 31 for buffalo, 82 for sheep, 92 for goat, 140 for pig, 2 for camel, 9 for horse, 31 for rabbit, 33 for duck, and 3226 for fowl), NGOs, Muths, Panjrapoles and Gaushalas (5151) of religious organizations which maintain indigenous animals. A total of 127 fodder seed production farms, 16 wool grading centres, 1632 sheep and wool extension cnetres, 637 hatcheries, 196 ICD projects, 58 Semen production centres, 213 frozen semen banks, 88095 AI centres are also being helping effective management of AnGR. For the health, management of AnGR, 11367 veterinary hospitals/polyclinics, 26034 veterinary dispensaries and 23722 veterinary aid centres/mobile dispensaries are functioning in India. The rearing and management of animals is an age-old tradition and farming communities are well-versed in the upkeep of animals.
• In addition to this Govt. of India has following programs for training and extension.
1. Dissemination of Technology/Extension
2. Livestock Credit and insurance
3. Human Resources/farmers training
4. Breeding farms (cattle, buffalo,sheep, goat, equine, camel and poultry)
Resource Limitation with respect to capacity development
1. Lack of trainers
2. Inadequate extension of technology to the stakeholders
3. Lack of local institutions like breed societies or herders groups/association.
4. Lack of IT infrastructure
5. Mostly livestock and poultry rearing is secondary occupation of most of the farmers in the country
6. Lack of harmony and coordination among different agencies.
c) Main policy and institutional constraints
1. Lack of regulations on management of livestock and poultry
2. Inadequate price policy, without farmers consents
3. Inadequate animal import and export regulations

4. Lack of proper regulations on livestock products sale and purchase
5. Lack of regulations on breeding of animals

d) Actions are required and what would be the priorities
1. Proper training of stakeholders on livestock scientific management.
2. Development of infrastructure for human resource
3. Development of IT infrastructure
4. Creation of interest of framers in livestock and poultry production.
5. Creation of harmony and coordination among different agencies
6. Proper regulations on management of livestock and poultry

Organizations responsible for implementing conservation and management of fisheries resources (State Fisheries Department) are inadequately staffed to cover vast geographic areas for implementation of different programmes. Due to diverse and complex multi-species aquatic productions systems dominated mainly by subsistence fishing, reaching out to small fishermen/ fish farmers is difficult.
Region specific capacity development programmes are required for different types of stakeholders such as state fisheries departments, fisher folks/ fish farmers, hatchery owners etc.

91. **With respect to knowledge generation and science for the management and sustainable use of biodiversity for food and agriculture:**

a. What are the major gaps in information and knowledge?
b. What are the main capacity or resources limitations?
c. What are the main policy and institutional constraints?
d. What actions are required and what would be the priorities?

a) Major gaps in information and knowledge

1. Large number of populations are awaiting registration to become new breeds
2. Inadequate trained technical manpower for carrying out breed-wise census.
3. Lack of watch list on Country's AnGR
4. Lack of research based on farmers issues/problems directly
5. Lack of research as per the farmers resource
6. Gaps in productivity of animals among the farmers and institutional herds
7. Gaps in management of animals among the farmers and institutional herds

b) Main capacity or resources limitations

1. Low productivity of indigenous livestock.
2. Poor implementation of breeding policies.
3. Lack of performance and pedigree recording at farmer's level.
4. Inadequate number of superior/proven bulls/bucks/rams/semen for AI and natural mating.
5. Inadequate funding for conservation of AnGR.
6. Insufficient patronage to native breeds.
7. Lack of local institutions like breed societies or herders groups/association.
8. Poor marketing system for animals, animal products and by products.
9. Inadequate insurance coverage of livestock and poultry.

c) Main policy and institutional constraints

1. Inadequate price policy, without farmers consents
2. Inadequate animal import and export regulations
3. Lack of proper regulations on livestock products sale and purchase
4. Lack of regulations on breeding of animals

d) Actions are required and what would be the priorities

1. Conducting accurate breed-wise livestock census for identification and enumeration of breeds and random sample surveys for revalidation through proper coordination between DAHD&F, State AH Deptts, and NBAGR.
2. Skill up gradation and imparting training to field functionaries.
3. Strengthening of AGRI-IS to include early-warning and response systems
4. Direct focus of research on farmers issues/problems

5. Development of production system involving farmers as per their resources
6. Incentives to the farmers
7. Identification, performance and pedigree recording system at farmer's door step should be strengthened through education and incentives.
8. Farmers should be provided superior males / germplasm of high genetic merit in regular manner.
9. Farmers should be acquainted with scientific breeding practices.
10. Common property resources and grazing land may be improved Proper policies that include health cover, shelter and conflict management during migration of Livestock.
11. Provide legal framework of protection and conservation of AnGR
12. Creation of national information management system on AnGR
13. Genetic slippage of AnGR to be checked
14. Proper marketing infrastructure needs to be developed

Microbes
1. There is no baseline information available in the country regarding the diversity of microorganisms in different ecosystems. This makes it difficult to identify the changes that have taken place in the microbial communities due to management practices or natural disasters or climate change.
2. It is required to develop microbial map of the country and the predominant genera of communities in different ecosystem needs to be identified.

Tools and techniques for cutting-edge areas like economic valuations of genetic resources to justify conservation research in quantifiable terms, impact of climate changes and disasters on aquatic biodiversity across various productions systems, risk assessment of exotic species is inadequate.
The collaborative efforts between biologists, economists and social scientists will be required to develop to model for economic valuations of biodiversity. There is need to add multiple dimensions such as international policy, legal frameworks and international trade, etc. into the research programmes which would contribute to the country's preparedness for meeting various national and global obligations.

CHAPTER 6: Future agendas for conservation and sustainable use of biodiversity for food and agriculture

Proposed structure of the chapter and information to be included in the Country Reports

This chapter provides an opportunity to describe plans and priorities to secure and improve the conservation and sustainable use of biodiversity for food and agriculture. Particular attention should be given to future opportunities to enhance the contribution of biodiversity for food and agriculture to food security and nutrition, as well as the elimination of rural poverty. Planned actions and initiatives should be listed that intend to support the following:

- Strengthening the contribution of biodiversity for food and agriculture to secure the multiple benefits of agriculture, including food security and nutrition, rural development, sustainable intensification, and the enhanced sustainability and resilience of production systems;
- Improving recognition and involvement of farmers, pastoralists, fishers and forest dwellers, addressing gender equality, and supporting the roles and contributions of women;
- Contributing to the UN Strategic Plan for Biodiversity and to achieving the Aichi Targets and linking to other related processes undertaken through the Convention on Biological Diversity.

Additionally, Chapter 6 allows an assessment of future needs with respect to policies and legal arrangements, economic frameworks, knowledge creation, capacity development and collaboration.

This part of the Country Report should build on the results presented in earlier Chapters and provide an integrated overview with, where possible, clear priorities for national, regional or global actions. This chapter is structured to benefit countries through an overall synthesis of information provided elsewhere in the report. Countries that previously presented or are currently preparing a Country Report on Forest, Aquatic, Animal or Plant Genetic Resources, may wish to take full advantage of their different sectoral reports to identify an overall perspective.

Enhancing the contribution of biodiversity for food and agriculture

This section provides an opportunity for countries to highlight their plans and priorities, and to describe current constraints to achieving them on enhancing the contribution of biodiversity for food and agriculture to human wellbeing, environmental health and sustainable production. Include any information that might be useful in informing future policies to help strengthen the contribution of biodiversity for food and agriculture to the broader sustainability and development objectives listed below.

92. **Describe planned actions and future priorities to improve the conservation and sustainable use of biodiversity for food and agriculture with specific reference to enhancing its contribution to:**

a. **improving food security and nutrition;**
b. **improving rural livelihoods;**
c. **improving productivity;**
d. **supporting ecosystem function and the provision of ecosystem services;**
e. **improving the sustainability and resilience of production systems;**
f. **supporting sustainable intensification.**

Refer to the future needs and priorities identified in previous Chapters. The different topics may be dealt with jointly or individually as appropriate to country plans and approaches. Replies should include country perspectives on:

- **Ways and means of improving the capacity and operations of the institutions within your country concerned with or affected by the maintenance and use of biodiversity for food and agriculture and particularly of associated biodiversity, including universities, government programmes, NGOs, breeders, private sector entities, organizations and social movements of small-scale producers. Actions to improve collaboration between stakeholders should be included.**

- **Ways and means of supporting the development of new policies or the implementation of the current policies that support the integrated conservation and sustainable use of biodiversity for food and agriculture, and that also specifically target associated biodiversity.**

- **The major information and knowledge gaps that remain to be addressed and options that exist to address them.**

Countries should indicate the ways in which planned actions will contribute to the UN Strategic Plan for Biodiversity and to achieving the Aichi Targets In particular Targets 6, 7, 13. as well as to how they link to other related processes undertaken through the Convention on Biological Diversity.

Crops
Ex-situ conservation of genetic resources for food and agriculture, establishment of germplasm repository, evaluation of exotic species, guidelines for safe introduction of exotic species.

Livestock
1. To prepare inventory and conserve the complete farm animal diversity in India through network project mode.
2. To improve the productivity among indigenous farm animal genetic resources particularly the cattle, buffalo, sheep and goat.
3. Providing quality food (Milk, Meat, Egg and their products) and value addition to food of animal origin.
4. To provide rural livelihood security to livestock keepers, landless labours and pastoralist possessing animal genetic resource of the country.
5. Improving and supporting sustainable animal production system.
6. To develop community based conservation programme to protect and improve farm animal biodiversity.
7. Creation of climate resilient animal production system.
8. Develop access and benefit sharing among the stakeholders.
9. Creation of National gene bank
10. Improvement of animals using molecular genetic and genomic approaches.
Following are the planned actions to support the conservation and management of biodiversity:

National livestock policy, Central herd registration scheme, All India coordinated research projects (AICRP), Rashtriya krishi vikas yojana (RKVY), National program for bovine breeding and dairy development (NPBBDD), National livestock mission (NLM), National kamdhenu breeding centre (NKBC), Livestock census and Network project on characterization and conservation of farm animal genetic resource, Network project on improvement of buffalo, sheep and goat.

Collaborative efforts are undertaken by several organizations under the regulatory framework at various levels for generation

and documentation of information on biodiversity at grassroots as well as national level, aquaculture diversification through sustainable use of indigenous species, evaluation of exotic fish species and sustainable utilization of biodiversity.

Strengthening the conservation and management of associated biodiversity and wild foods

This section provides an opportunity for countries to highlight their plans and priorities, and to describe current constraints to achieving them on the conservation and management of associated biodiversity and of wild foods.

93. **Describe planned actions and future priorities to support conservation and management of the components of associated biodiversity and wild foods including the development of monitoring programmes and of information systems or databases.**

Replies should cover country perspectives on:

- **Ways and means of improving the capacity and operations of the institutions within your country concerned with or affected by the maintenance and use of biodiversity for food and agriculture and particularly of associated biodiversity, including universities, government programmes, NGOs, breeders, private sector entities, organizations and social movements of small-scale producers. Actions to improve collaboration between stakeholders should be included;**

- **Ways and means of supporting the development of new policies or the implementation of the current policies that support the integrated conservation and sustainable use of biodiversity for food and agriculture, and that also specifically target associated biodiversity;**

- **The major information and knowledge gaps that remain to be addressed and options that exist to address them.**

Establishment of Network of Regional Live Germplasm Resource Centers to support aquaculture diversification, conservation and support in situ conservation. The programme will be knowledge based for developing technology and monitoring the trends on resources and socio-environmental impacts.

94. **Describe planned actions and future priorities with respect to implementing ecosystem approaches for the various components of biodiversity for food and agriculture.**

• Priorities may be decided based on the quantum of genetic diversity and eco-geographical fragility of areas, for instance, NEH states, NW Himalayas, and Western Ghats.
• Identifying most appropriate sites including gene sanctuaries, national parks and forest reserves as hotspots for conservation of CWR diversity
• Integrating neglected and underutilized species in the crops growing models in general and eco-geographically fragile areas in particular to in the eventualities of radical environmental stresses (stochastic events).
• Document information on landraces and crops that survive stochastic events as they are likely to be well adapted to the particular stress, and future generations may possess that adaptation.
• Modalities to repatriate the diversity in disaster situations in the event of large scale diversity loss in reference region to be put in place.
• Minimising the infestation of invasive aliens and ingenious notorious weeds and weedy species in and around the close proximity of cultivated crops, adjoining agro-forestry systems, disturbed and semi-cultivated habitats around farmlands owing to their richness in crop wild relatives diversity
• Encourage afforestation of crop wild relatives in the habitats of their occurrence through in-situ seeding and planting.
• The live germplasm resource centers will allow harnessing dual potential in conservation and aquaculture diversification. The material raised in the process will be used for stock enhancement, rehabilitation in wild and ensuring that genetic make up of respective species in the wild is not altered.
• Greater efforts towards capacity development of stakeholders including state fisheries department officials and fisher folks will lead to enhanced implementation of ecosystem based approach in various aquatic production systems.

Improving stakeholder involvement and awareness

This section provides an opportunity for countries to highlight their plans and priorities, and to describe current constraints to achieving them with respect to stakeholder involvement in the conservation and sustainable use of biodiversity for food and agriculture with specific reference to the recognition and involvement of farmers, pastoralists, fishers and forest dwellers, addressing gender equality, and supporting the roles and contributions of women.

95. **Describe planned actions and future priorities to improve stakeholder awareness, involvement and collaboration in the conservation and sustainable use of biodiversity for food and agriculture. Include a description of the major challenges that will need to be overcome.**

Plants
• The ecological, economic, social and cultural values of PGRFA, including their importance in crop improvement for increasing food security, mitigating climate change challenges, be recognized in national planning and policies.
• For geospatial databases, various agencies involved like NBSS LUP, BSI, CSIR, DRDO (those involved in agrobiodiversity) needs to be identified and a portal with information and identified gaps to be developed with their collaboration
• Generate data on the extent and nature of genetic erosion for particular crops in specific areas with modern molecular and genomic techniques.
• Evolve better techniques and indicators for monitoring genetic diversity, for establishing baselines and monitoring trends to be implemented
• Periodically review and report on the PGRFA, assess threats and deploy methods to minimize threats
• Identify species and populations that are at maximum risk and are most likely to possess traits that would be important in the future; this is particularly important with regard to farmers' varieties/landraces
• Take into account the important roles of indigenous and local communities in any in situ conservation or on-farm management effort, and their traditional knowledge systems and practices
• Public awareness materials should be produced in appropriate languages

Livestock
Animal husbandry in India is a state (provincial) subject and each state government has established a network of veterinary hospitals, poly-clinics, and dispensaries. These institutions are organizing health camps, fertility camps, animal-fairs and livestock keepers' meetings to empower them.
• Krishi Vigyan Kendras established in almost all the districts are also disseminating technical knowledge to the stake-holders.
• Breed societies have been established for a few livestock breeds.
• NGO's are partially funded by the government for different kinds of activities related with management of AnGR like Breed Saviour Awards.

Following are the planned actions to support the conservation and management of biodiversity:
National livestock policy, Central herd registration scheme, All India coordinated research projects (AICRP), Rashtriya krishi vikas yojana (RKVY), National program for bovine breeding and dairy development (NPBBDD), National livestock mission (NLM), National kamdhenu breeding centre (NKBC), Livestock census and Network project on characterization and conservation of farm animal genetic resource, Network project on improvement of buffalo, sheep and goat.

Major Challenges includes
1. Small herd size of the animals per house hold which hampers the animal improvement efforts, needs to be overcomed
2. Education of livestock keepers and farmers involved in animal husbandry
3. Improved linkage and frequent interactions among various central and state government departments along with involvement of stake holders, NGO's is imperative
4. Create central pool on data recording and data storage facilities, on farm animal performance recording for their efficient improvement.

Regional level targeted awareness and training programmes for promoting culture dependent consumption of the vulnerable components of biodiversity and implementing alternate livelihood options through culture.

96. **Describe planned actions and future priorities to support the role of farmers, pastoralists, fisher folk, forest dwellers, and other rural men and women dependent on local ecosystems in the conservation and use of biodiversity for food and agriculture. Replies should include information on recognizing and enhancing the role of indigenous peoples. Include a description of the major challenges that will need to be overcome.**

Plants
Protection of Plant Varieties and Farmers' Rights Authority has been established In order to provide for the establishment of an

effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants it has been considered necessary to recognize and protect the rights of the farmers in respect of their contribution made at any time in conserving, improving and making available plant genetic resources for the development of the new plant varieties. Moreover to accelerate agricultural development, it is necessary to protect plants breeders' rights to stimulate investment for research and development for the development of new plant varieties.Such protection is likely to facilitate the growth of the seed industry which will ensure the availability of high quality seeds and planting material to the farmers.

Livestock

1. Providing rights of pastoralist to allow grazing for their livestock in forest areas.
2. Promotion of ITKs and community based livestock conservation with enhancing the role of stakeholder's needs attention.
3. Protection of animal breeds and livestock keepers' right through an act and policies by government should be planned.
4. Creation of marketing facilities for food at national level.

Strategic documentation of socio-economic impact of conservation need planned programmes. Encouraging conservation aquaculture for low trophic and easy to propagate indigenous species which can be put through a framework of harmonising the use and conservation of aquatic biodiversity.

97. **Describe planned actions and future priorities to improve recognition of the contribution of women to the conservation and use of the different components of biodiversity for food and agriculture, including associated biodiversity. Include a description of the major challenges that will need to be overcome.**

Plants

Strengthen participatory appraisal techniques and encourage formation of local institutional structures for planning and management of natural resources for ensuring participation of women. Designing and implementing awareness programmes, particularly for rural women, and also benefit from their from their wisdom. Women's organizations such as women's councils and mahila mandals are used for this purpose. The National Rural Livelihoods Mission (NRLM) initiated livelihood enhancement and vulnerability reduction interventions
through a special programme, Mahila Kisan Sashakti karan Pariyojana (MKSP), launched in 2010-2011. The programme envisages empowering women in agriculture by making systematic investments to enhance their participation and productivity, as also create and sustain agriculture-based livelihoods among rural women. The programme is being
implemented by NRLM in partnership with State Departments, as implementing partners, across the country. The main focus of NRLM is to stabilize and promote the existing livelihoods portfolio of the poor, in farm and non-farm sectors.
NRLM looks at the entire portfolio of livelihoods of each household and facilitate support for the activities at the individual/ household level or in a collective, or at both levels. As agriculture is the mainstay of livelihoods activities for a large proportion of the rural poor, NRLM specially focuses on sustainable agriculture and allied activities such as animal husbandry, collection non-timber forest produce and fisheries.

Biodiversity Management Committees have been setup under Biological Diversity Act for conservation, sustainable use and documentation of biodiversity and chronicling traditional knowledge. This is also in line with constitutional amendment number 73 of 1993 that enshrines democratic decentralization of responsibilities, wherein local bodies consisting of elected representatives, one third of whom are women, are entrusted with the responsibility of safeguarding local environmental capacity stocks. So far 32,210BMCs have been constituted by local bodies in 23 States (nbaindia.org).

Livestock

Women are already the major contributor in maintaining farm animal genetic resources and their biodiversity. In India and around fifty percent of the work force in animal husbandry comes from women, particularly in rural parts of India. Women play an important role in animal husbandry activities as manager, decision makers and skilled workers. They help in farm operations, take their animals for grazing, look after the sale of milk, and in addition, perform the functions related to house management. Many of such important tasks in animal husbandry are performed by women besides their responsibilities as home makers and caring of animals is considered as an extension of domestic activities. The role of dairy farm women is not recognized as economic contribution and they remain as unpaid labour.

Aquaculture

Region-specific targeted awareness and training programmes on various conservation measures implemented are needed for women involved in fishing enterprises. Mechanisms to ensure greater participation of women fisherfolks in aquatic resource management activities would lead to their enhanced contribution to the conservation of biodiversity.

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ANNEX 1: Recommended scope of the Country Report

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 agriculture products. 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.

The present Guidelines for the SoWBFA mainly focus on those areas not covered by completed or on-going Country Reports on Animal, Forest, Plant and Aquatic Genetic Resources, e.g. the biological diversity associated with different supporting and regulating ecosystem services within production systems or of importance to them, referred to hereinafter as associated biodiversity, and wild resources used for food.

Associated biodiversity

For the scope of this report, 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;

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.

Note that domesticated species may also provide ecosystem services other than provisioning ones and affect crop, animal, fish and forest production in different ways. However since these species are already addressed in other State of the World Reports, countries may choose whether or not they want to include them in their Country Reports for the SoWBFA.

Integrated analysis of biodiversity for food and agriculture

The scope of the Report builds upon the contribution of individual sector reports by providing an integrative analysis of interactions, including synergies, interlinkages and trade-offs, between genetic resources of the different sectors. This is achieved through the identification of production systems within the country (Annex 2), and particular focus upon ecosystem perspectives in relation to biodiversity for food and agriculture. Questions addressing overall biodiversity for food and agriculture target information that would build upon what may be available in previous or ongoing country reports.

ANNEX 2: Production systems

Table 1. Climatic zones definitions

Climatic zone	Definition
Tropics	All months with monthly mean temperature, corrected to sea level, above 18°C.
Subtropics	One or more months with monthly mean temperatures, corrected to sea level, below 18°C but above 5 °C.
Temperate	At least one month with monthly mean temperatures, corrected to sea level, below 5 °C and four or more months above 10 °C.
Boreal	At least one month with monthly mean temperatures, corrected to sea level, below 5 °C and more than one but less than four months above 10 °C.

Table 2. Production systems descriptions

Name of production system	Climatic zone	Description
Livestock grassland-based systems	Tropics	Systems in which the animals obtain a large proportion of their forage intake by grazing natural or sown pastures, includes: • Ranching: grassland-based systems in which livestock is kept on privately owned rangeland • Pastoralist: grassland-based systems in which the livestock keepers move with their herds or flocks in an opportunistic way on communal land to find feed and water for their animals (either from or not from a fixed home base)
	Subtropics	
	Temperate	
	Boreal and /or highlands[1]	
Livestock landless systems	Tropics	Systems in which livestock production is separated from the land where the feed given to the animals is produced.

[1] High elevation montane environments where climate differs significantly from surrounding lower elevation areas, including alpine and sub-alpine zones, tropical highlands, dryland mountains, etc.

	Subtropics	
	Temperate	
	Boreal and /or highlands	
Naturally regenerated forests	Tropics	Includes: • Primary: Forests of native species, where there are no clearly visible indications of human activities and the ecological processes are not directly disturbed by humans • modified natural: Forests of naturally regenerated native species where there are clearly visible indications of significant human activities • semi-natural (assisted natural regeneration): Silvicultural practices in natural forest by intensive management (weeding, fertilizing, thinning, selective logging)
	Subtropics	
	Temperate	
	Boreal	
	Boreal and /or highlands	
Planted forests	Tropics	Includes : • semi-natural (planted component) : Forests of native species, established through planting or seeding, intensively managed • Plantations (productive) : Forests of introduced and/or native species established through planting or seeding mainly for production of wood or non-wood goods • Plantations (protective) : Forests of introduced and/or native species, established through planting or seeding mainly for provision of services
	Subtropics	
	Temperate	
	Boreal	
	Boreal and /or highlands	
Self-recruiting capture fisheries	Tropics	Includes capture fisheries in marine, coastal and inland areas that can involve • Natural ecosystems • Modified ecosystems e.g. reservoirs and rice paddies;
	Subtropics	
	Temperate	
	Boreal	
Culture-based fisheries	Tropics	Fisheries on resources, the recruitment of which originates or is supplemented from cultured stocks (i.e., populations chosen for culture and not stocks in the same sense as that term is used for capture fisheries) raising total production beyond the level sustainable through natural processes.
	Subtropics	
	Temperate	
	Boreal and /or highlands	
Fed aquaculture	Tropics	The farming of aquatic organisms including fish, mollusks, crustaceans, aquatic plants, crocodiles, alligators, turtles and amphibians. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators etc. Farming also implies individual or corporate ownership of the stock being cultivated; i.e., the population chosen for culture and not a stock in the same sense as that term is used for capture fisheries. Fed aquaculture production utilizes or has the potential to utilize aquafeeds of any type in contrast with the farming of filter-feeding invertebrates and aquatic plants that relies exclusively on natural productivity. Also defined as "farming of aquatic organisms utilizing aquafeeds in contrast to that deriving nutrition directly from nature".
	Subtropics	
	Temperate	
	Boreal and /or highlands	
Non-Fed aquaculture	Tropics	The farming of aquatic organisms including fish, mollusks, crustaceans, aquatic plants that do not need supplemental feeding. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators etc. Farming also implies individual or corporate ownership of the stock being cultivated; i.e., the population chosen for culture and not a stock in the same sense as that term is used for capture fisheries. In non-fed aquaculture systems culture is predominately dependent on the natural environment for food, e.g. aquatic plants and mollusks.
	Subtropics	
	Temperate	
	Boreal and /or highlands	
Irrigated crops (rice)	Tropics	Irrigated rice refers to areas where rice is cultivated purposely provided with water, including land irrigated by controlled flooding.
	Subtropics	
	Temperate	
	Boreal and /or highlands	
Irrigated crops (other)	Tropics	Irrigated crops other than rice refers to agricultural areas purposely provided with water, including land irrigated by controlled flooding.
	Subtropics	
	Temperate	
	Boreal and /or highlands	

Rainfed crops	Tropics	Agricultural practice relying exclusively on rainfall as its source of water.
	Subtropics	
	Temperate	
	Boreal and /or highlands	
Mixed production systems (livestock, crop, forest and /or aquatic and fisheries mixed)	Tropics	Production systems with multiple components. They include: • Crop-livestock: mixed systems in which livestock production is integrated with crop production. • Agro-pastoralist: livestock-oriented systems that involve some crop production in addition to keeping grazing livestock on rangelands; they may involve migration with the livestock away from the cropland for part of the year; in some areas, agropastoral systems emerged from pastoral systems • Agroforestry-livestock: mixed system in which livestock production is integrated with the production of trees and shrubs[56] • Integrated aquaculture: mixed systems in which aquaculture is integrated with crop and livestock production. May involve ponds on farms, flooded fields, enrichment of ponds with organic waste, etc. • Other combinations
	Subtropics	
	Temperate	
	Boreal and /or highlands	

ANNEX 3: Drivers of change

Table 1. Drivers of change and descriptions.

Drivers	Description, Subcategories and Examples
Changes in land and water use and management	A change in the use, management and practices around land and water (e.g., deforestation; fragmentation; modification of water regimes; forest degradation; land conversion for agriculture; ecosystem restoration; the role of women and men in land and water use and management, etc.)
Pollution and external inputs	The mismanaged, excessive or inappropriate use of external inputs (e.g., over application of fertilizer and pesticides; excessive use of antibiotics or hormones; nutrient loading, including from use of imported feed; ocean acidification, CO_2 fertilization; chemical and particulate pollutants, etc.
Over-exploitation and overharvesting	Unsustainable extraction practices (e.g., overfishing; overhunting; overgrazing; logging and extractive activities exceeding replacement rates or affecting species of uncertain and at-risk conservation status, etc.)
Climate change	The impacts and effects of progressive climate change (e.g., alterations in precipitation regimes; temperature changes; loss of water supply; increased variability; sea level rise; shifts in flowering time or seasonality, etc.)
Natural disasters	Climate shocks, extreme weather events and other natural disasters that threaten agricultural production and resilience of production systems (e.g., hurricanes, earthquakes, floods, fires).
Pests, diseases, alien invasive species	New and emerging threats from pests, diseases and invasive species affecting biodiversity for food and agriculture (e.g., shifting ranges; introductions; increased suitability; loss of predator, etc.)
Markets, trade and the private sector	**Trade-** Changing terms of trade, globalization of markets, commercialization of products, retailing, the separate capacities of women and women to commercialize products, etc. **Markets and consumption** - Demand driven changes in production or practices including the tastes, values or ethics of consumers that may impact directly or indirectly biodiversity for food and agriculture, product quantity or quality **Private sector** - The changing role and influence of private sector and corporate interests
Policies	**Policies** - Global, regional, national, and subnational legislation and regulations (e.g., conservation regulations, participation and compliance with International treaties and conventions); **Economic and policy interventions** - Interventions that impact biodiversity for food and agriculture directly or indirectly (e.g., taxes, subsidies, charges for resource use, payments for ecosystem services) **Intellectual Property Rights (IPR), Access and Benefit Sharing (ABS)** - Direct or indirect impacts of IPR and ABS policy and regulations on biodiversity for food and agriculture.
Population growth and urbanization	**Population** - Changes in population metrics (e.g., growth, fertility, composition, mortality, migration, health and disease, including different affects on men and women.) **Urbanization-** (e.g., shifts in proportion of urban and rural; change in urbanization trends, including different effects on men and women)
Changing economic, socio-political, and cultural factors	**Economic development** - A change in economic circumstances of countries, industries, households (e.g., change in GDP and economic growth; structural change of economy; income diversification, and the different economic circumstances of men and women.) **Changing socio-political, cultural or religious factors** - Variation in the forces influencing decision-making of men and women, e.g., public participation, shifts in the influence of the state vs. private sector, changes in levels of education and knowledge, shifts in the beliefs, values and norms held by a group of people. **Participatory actions** – the role of collective action toward conservation and use of biodiversity by stakeholders
Advancements and innovations in science and technology	The development and diffusion of scientific knowledge and technologies, (e.g., advances in breeding; improvements in mobile extension; tools for monitoring; biotechnology applications, access of men and women to information).

ANNEX 4: Ecosystem services

The SoWBFA Guidelines focus primarily on regulating and supporting ecosystem services, described below. Provisioning services relating to biodiversity for food and agriculture are the focus of sectoral State of the World Reports, and are addressed in these guidelines only in relation to associated biodiversity and wild foods, which often fall outside of traditional sectoral reporting. Countries may choose to address additional ecosystem services, including cultural services, for the completion of national reports, particularly where they are directly relevant to the objectives of the SoWBFA Report[2].

Table 1. Regulating and supporting ecosystem services.

Category	Ecosystem services	Description	Relevant ecosystem functions
Regulating services	Pollination	Role ecosystems play in transferring pollen from male to female flower parts	Agricultural productivity; production of food and goods.
	Pest and disease regulation	Influence ecosystems have on the prevalence of crop and livestock pests and diseases	Biological control; the maintenance and feedback mechanisms preventing outbreaks of pests and diseases, including invasive species.
	Water purification and waste treatment	Role ecosystems play in the filtration and decomposition of organic wastes and pollutants in water; assimilation and detoxification of compounds through soil and subsoil processes	Filtering function performed by vegetation cover, soil and aquatic biota.
	Natural hazard regulation	Capacity for ecosystems to ameliorate and reduce the damage caused by natural disasters	Vegetative structure can alter potentially catastrophic effects of storms, floods and droughts through its storage capacity and surface resistance; coral reefs buffer waves and protect adjacent coastlines from storm damage. The services provided by this function relate to providing safety of human life and human constructions.
Supporting services	Nutrient cycling	Flow of nutrients (e.g., nitrogen, sulfur, phosphorus, carbon) through ecosystems	Maintenance of fertility; regulation of excess nutrients; climate regulation; regulation of biotic communities
	Soil formation and protection	Degradation of ecosystems, such as decomposition of organisms or weathering of substrate, to form soil	Maintenance of crop productivity on cultivated lands and the integrity and functioning of natural ecosystems.
	Water cycling	Flow of water through ecosystems in its solid, liquid, or gaseous forms	Regulation of hydrological flows at the earth surface. Maintenance of natural irrigation and drainage, buffering of extremes in discharge of rivers, regulation of channel flow, and provision of a medium for transportation.
	Habitat provisioning	Role of ecosystems in creating and maintaining habitats for a wide variety of organisms	Providing diverse and suitable habitats for species; nursery function for migratory species and as breeding areas.
	Production of oxygen/ Gas regulation	The creation of atmospheric oxygen through photosynthesis	Gas regulation functions include the maintenance of clean, breathable air, and the prevention of diseases (e.g. skin cancer, asthma) May include regulation of the CO_2/O_2 balance, maintaining ozone-layer (O_3), and regulation of SOx levels.

ANNEX 5: Management practices supporting the use and conservation of biodiversity for food and agriculture

Table 1. Management practices supporting the use and conservation of biodiversity for food and agriculture.

Management practices supporting the use and conservation of biodiversity for food and agriculture	Description/ examples of management practices
Integrated Plant Nutrient Management (IPNM)	Soil, nutrient, water, crop, and vegetation management practices undertaken with the aim of improving and sustaining soil fertility and land productivity and reducing environmental degradation, often tailored to a particular cropping and farming system. May include the use of farmyard manures, natural and mineral fertilizers, soil amendments, crop residues and farm wastes, agroforestry and tillage practices, green manures, cover crops, legumes, intercropping, crop rotations, fallows, irrigation, drainage, plus a variety of other agronomic, vegetative and structural measures designed to conserve both water and soil.
Integrated Pest Management (IPM)	Pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment by encouraging natural pest control mechanisms that include: crop rotation; inter-cropping; seedbed sanitation, sowing dates and densities, under-sowing, conservation tillage, pruning and direct sowing; where appropriate, use of pest resistant/tolerant cultivars, push-pull strategies and standard/certified seed and planting material; balanced soil fertility and water management, making optimum use of organic matter; prevent spreading of harmful organisms by field sanitation and hygiene measures; protection and enhancement of important beneficial organisms.
Pollination management	Practices that accomplish or enhance pollination of a crop, to improve yield or quality, by understanding of the particular crop's pollination needs, and by knowledgeable management of pollenizers, pollinators, and

[2] Including those described in the Millennium Ecosystem Assessment, or subsequent adaptations by the TEEB or other sources.

	pollination conditions. Pollinator-friendly practices include minimizing the use of agrochemicals, integrated pest management and mixed cropping to include pollinator friendly crops, preserving wild habitats, maintaining flower-rich field margins, buffer zones and permanent hedgerows to ensure habitat and forage, cultivating shade trees, managing for bee nest sites, and establishing landscape configurations that favor pollination services.
Landscape management	Practices that support the maintenance of biodiversity friendly farming systems, or the diversity of landscape mosaics within and surrounding production systems over particular geographic areas. Examples include riparian corridors, hedges, margins, woodland patches, clearings in forests, ponds or other biodiversity friendly features characteristic of the production environment that may be the result of national or regional policies such as the EU set aside schemes.
Sustainable soil management practices	Management of soil biodiversity to enhance agricultural production by both direct and indirect means, including alteration of the abundance or activity of specific groups of organisms through inoculation and/or direct manipulation of soil biota. Indirect interventions may include manipulation of the factors that control biotic activity (habitat structure, microclimate, nutrients and energy resources) rather than the organisms themselves such as the maintenance of soil cover with organic mulch including crop residues, green manure/cover crops including legumes, and compost to increase soil organic matter, irrigation and liming, as well as cropping system design and management.
Conservation agriculture	Conservation Agriculture (CA) aims to achieve sustainable and profitable agriculture and improve livelihoods of farmers through the application of the three CA principles: no or minimal soil disturbance through direct seeding into untilled soils, maintenance of permanent soil mulch cover, and crop diversification through rotations, associations and sequences.
Water management practices, water harvesting	Water harvesting and management through rain water retention or modification of the landscape (e.g., bunds, zais, terracing) for the restoration and improvement of degraded lands, and to allow cultivation of additional crops with higher water requirements, and improving water productivity of crops.
Agroforestry	Agroforestry is a collective name for land-use systems where woody perennials (trees, shrubs, palms, etc.) are integrated in the farming system.
Organic agriculture	Organic agriculture is a production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system.
Low external input agriculture	Production activity that uses synthetic fertilizers or pesticides below rates commonly recommended for intensive industrial tillage agriculture. It does not mean elimination of these materials. Yields are maintained through greater emphasis on agronomic practices, IPM, and utilization of on-farm resources (especially labor) and management.
Home gardens	An integrated system which comprises different components in a small area around the homestead, including staple crops, vegetables, fruits, medicinal plants, livestock and fish both for home consumption or use and for income. May include the family house, a living/playing area, a kitchen garden, a mixed garden, a fish pond, stores, an animal house, etc.
Areas designated by virtue of production features and approaches	These include areas recognized nationally or internationally by virtue of their landscape and agricultural features. In addition to Satoyama, GIAHS, national parks (IUCN categories), they also include areas recognized for specific agricultural products (e.g. DOP, IGP or Slow Food).
Ecosystem approach in capture fisheries	Approach promoting the diversity of the whole ecosystem in order to support the target species. Considerations include sustainable harvesting of the retained species (target and by-product species); managing the direct effects of fishing (especially on non-retained by-catch and habitat); and managing the indirect effects of the fishery on ecosystem structure and processes.
Conservation hatcheries	Hatcheries and production systems that optimize natural levels and organization of genetic diversity over production. Often for rebuilding depleted populations of commercially important species, (e.g. Atlantic and Pacific salmon).
Reduced-impact logging	A series of practices to improve logging practices such as vine removal, directional felling, limiting skid trails, logging roads and stumping grounds, restrictions on the size and number of trees felled, and post felling removal of waterway blockages, to reduce the residual damage, biodiversity loss and excess CO_2 emissions associated with conventional logging practices.

ANNEX 6: Diversity based interventions

Table 1. Diversity based practices and interventions

Diversity based practices	Description/ examples of interventions
Diversification	The introduction of new varieties, species, and groups of organisms (e.g., livestock, crops, trees, fish) into a production system or managed environment without replacement or abandonment of other groups, or the maintenance of already-existing diversity in the case of traditionally diverse production systems. May include introductions for restoration or IPM objectives, including fish introduced to control reproduction.
Base broadening	Increasing the amount of genetic diversity used to produce new varieties or breeds used in agricultural production.
Domestication	The development of new crop, aquatic, forest and animal species through deliberate breeding programmes or the continued selection and improvement of existing species from their wild progenitors. These activities may be carried out by national breeding programmes or by farmers and communities themselves.
Maintenance or conservation of landscape complexity	Maintenance or management of components of a landscape mosaic including hedges, waterways, road margins, corridors, windbreaks, living fences, native grasses wild patches of vegetation in the farming landscape, etc.
Restoration practices	Restoring functionality and productive capacity to ecosystems, forests, landscapes, waterways, grasslands and rangelands in order to provide food, fuel, and fiber, improve livelihoods, store carbon, improve adaptive capacity, conserve biodiversity, prevent erosion and improve water provisioning and quality.

Management of micro-organisms	The intentional incorporation, management or maintenance of microbes, fungi and other micro-organisms into a production system or organisms; e.g., inoculation of plants and seeds with arbuscular mycorrhizal fungi, the addition of probiotics in aquaculture and livestock, etc.
Polyculture/Aquaponics	Integrated multi-trophic aquaculture, utilization of different trophic and spatial niches of an aquaculture system in order to obtain maximum fish production per unit area, utilizing natural resource availability.
Swidden and shifting cultivation agriculture	Rotation of plots from intensive cultivation to extended fallow periods for the replenishment of soil fertility.
Enriched forests	Selective logging and enrichment planting to increase the abundance of useful species for food, medicine and timber, often a feature of traditional management practices.