"To become a premier institute on biodiversity for effective conservation, sustainable utilization and equitable sharing of benefits arising from access and use of biological resources"

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National Biodiversity Centre Vision 2030

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Vision 2030

Ministry of Agriculture and Forests
Royal Government of Bhutan

National Biodiversity Centre

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Abbreviations and Acronyms

ABC:	Agrobiodiversity Conservation
ABS:	Access and Benefit Sharing
AFACI:	Asia Food and Agriculture Cooperation Initiative
AnGR:	Animal Genetic Resources
ARDC:	Agriculture Research and Development Centre
BABS Fund:	Bhutan Access and Benefit Sharing Fund
BBP:	Bhutan Biodiversity Portal
BDNJ:	Biodiversity Network Japan
BIMP:	Biodiversity Information Management Program
BPPL:	Bhutan Pharmaceutical Private Ltd.
BTFEC:	Bhutan Trust Fund for Environmental Conservation
BUCAP:	Biodiversity Use and Conservation in Asia Program Project
CEPA:	Communication, Education and Public Awareness
CGRFA:	Commission on Genetic Resources for Food and Agriculture
CNR:	College of Natural Resources
CPB:	Chanel Parfums Beaute
CSB:	Community Seed Bank
CWR:	Crop Wild Relatives
DAD-IS:	Domestic Animal Diversity Information System
DANIDA:	Danish International Development Agency
DNA:	Deoxyribonucleic Acid
DoL:	Department of Livestock
EBP:	Evolutionary Plant Breeding
ESP:	Elementary Service Personnel
EU-GCCA:	European Union Global Climate Change Alliance Project
EU-SSP:	European Union - Sector Support Project
EU-TCP:	European Union - Technical Cooperation Project
FAO:	Food and Agricultural Organization
FYP:	Five Year Plan
GBP:	Great Britain Pound
GEF:	Global Environment Facility
GNH:	Gross National Happiness
GRPI:	Genetic Resources Policy Initiative
HANAS:	High Altitude Northern Areas of Bhutan
ICT:	Information and Communication Technology
ILCCP:	Integrated Livestock and Crop Conservation Project
IMPGR:	Integrated Management of Plant Genetic Resources
IP:	Intellectual Property

ITPGRFA:	International Treaty for Plant genetic Resources for Food and Agriculture
IUCN:	International Union for Conservation of Nature
LN2:	Liquid Nitrogen
MHPA:	Mangdechu Hydro Power Authority
MLS:	Multilateral System
MoA:	Memorandum of Agreement
MSPCL:	Menjong Sorig Pharmaceutical Corporation Ltd.
MTA:	Material Transfer Agreement
NBC:	National Biodiversity Centre
NBP:	National Biodiversity Program
NBSAP:	National Biodiversity Strategies and Action Plan
NDRC:	National Dairy Research Centre
NFI	National Forest Inventory
NGS:	Nimura Genetic Solutions
NPIF:	Nagoya Protocol Implementation Fund Project
NPPC:	National Plant Protection Centre
NUS:	Neglected and Under-Utilized Species
PGR:	Plant Genetic Resources
PGRFA:	Plant Genetic Resources for Food and Agriculture
PPB:	Participatory Plant Breeding
PSC:	Program for South-South Cooperation
PVS:	Participatory Varietal Selection
QPL:	Quantum Pharmaceuticals Ltd.
RBGS:	Royal Botanical Garden Serbithang
RGoB:	Royal Government of Bhutan
RSPN:	Royal Society for Protection of Nature
SDS:	Sustainable Development Secretariat
SEARICE:	South East Asia Regional Initiatives for Community Empowerment
SJI:	Samdrup Jongkhar Initiative
SNBL:	Shin Nippon Biomedical Laboratories Ltd.
THIM:	National Herbarium of Bhutan
TK:	Traditional Knowledge
UNCBD:	United Nations Convention on Biological Diversity
UNCCD:	United Nations Convention to Combat Desertification
UNEP:	United Nations Environment Programme
UNFCCC:	United Nations Framework Convention on Climate Change
USD:	United States Dollar
UWICER:	Ugyen Wangchuck Institute for Conservation and Environmental Research
WWF:	World Wide Fund for Nature

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A: SITUATIONAL ANALYSIS

1. Background

1.1. Biodiversity and Bhutan

Biological diversity is vitally important for every sphere of human existence and provides us with a vast range of products and services ranging from food, water, timber, fibre, genetic resources, and medicines to recreational, aesthetic, and spiritual benefits as well as regulation of climate, water and soil quality, and pollination among others. In the context of Bhutan, not only has the conservation of biological diversity always played a pivotal role in Bhutan's development history but concern for the natural environment and biological diversity is deeply embedded in Bhutanese traditional beliefs, socio-cultural outlook and the overarching development philosophy of Gross National Happiness (GNH). As a result, Bhutan has emerged virtually unscathed in the twenty first century in terms of its biological wealth. The country has 71 percent (National Forest Inventory, 2016) of the total area under forest cover and 51.44 percent (Forestry Facts and Figures, 2016) secured as protected areas and biological corridors and is home to a diverse array of flora and fauna including 5,603 species of seed plants, 411 species of ferns, more than 200 species of mammals and over 700 bird species. To date, over 300 species of medicinal plants have been found at altitudes ranging from 100 to over 5,000 metres above sea level. In terms of domestic biodiversity, there are more than 80 species of agricultural crops and 10 species of livestock. Some of these have adapted to the country's rugged mountains and harsh climatic conditions and, therefore, bear distinctive features which need to be conserved especially to build resilience in the face of climate change for food security and improved livelihoods. About 69 percent of the Bhutanese population depends on natural resources for their livelihoods and the figure could be significantly higher if we take into account non-rural people dependent on other natural resources such as timber which justify the paramount importance of conservation and sustainable utilization of biodiversity to Bhutan and its people.

The nation's strong commitment to the environment is also apparent from the fact that the Constitution of the Kingdom of Bhutan mandates the country to maintain at least 60 percent forest cover for all time to come. Internationally as well, Bhutan has spearheaded environmental commitments such as staying

carbon-neutral and fostering regional climate change cooperation and is party to many international instruments committed to protecting the environment such as the United Nations Convention on Biological Diversity (UNCBD), United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Convention to Combat Desertification (UNCCD), among others. The Bhutan Trust Fund for Environmental Conservation (BTFEC) which was established through the command and guidance of His Majesty the Fourth King, is now a robust fund that has supported and continues to support various national initiatives to protect the environment.

On November 11, 2017 the Bhutan for Life Initiative, a strategic and long term project aimed at ensuring that Bhutan remains economically and environmentally sustainable was also formally launched by Her Majesty the Gyaltsuen, coinciding with the birth anniversary of His Majesty the Fourth Druk Gyalpo.

Nevertheless, it is not enough to rest on past laurels and remain passive in the face of emerging challenges such as fast economic growth, increasing rural-urban migration, expanding urbanization, increased need for forest resources, human wildlife conflict etc. which impacts environmental conservation in one way or the other. The increasing pressure on the nation's coffers from the growing needs of the population also has implications on the growing cost of conservation for the sake of conservation alone. There is also a need to be cognizant of the fact that in the face of increasing erosion of biodiversity in the neighboring countries due to the constant struggle between conservation and fast socio-economic development as well as an expanding population and the threat of changing climate, the value of Bhutan's natural resources will increase in terms of relative importance, presenting numerous opportunities for deriving benefits. Given these considerations, it is imperative that the government invests strongly in strengthening national capacities particularly in developing a sound scientific knowledge base of Bhutan's rich biological diversity and tapping the opportunities from biodiversity for effective utilization of our biological resources in a sustainable manner.

1.2. History of NBC

Bhutan became party to and ratified the UN Convention on Biological Diversity (CBD) in 1995 by the 73rd session of the National Assembly, in recognition of the importance of biodiversity to humankind and to its own goal of environmentally sustainable development and committed leadership in environmental conservation. The CBD is one of the most comprehensive international agreements, signed by 193 countries committed to the conservation and sustainable utilization of biological resources and the fair and equitable sharing of benefits arising from access to biological resources. Bhutan also signed the Nagoya Protocol on Access and Benefit Sharing in 2011 to enable meaningful ABS collaborations that will benefit the country and the people at large through regulated access to biological resources in the country. The National Biodiversity Centre was designated as the National Focal Point for Nagoya Protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization at the 44th Commission meeting of the National Environment Commission.

With the ratification of the Convention, Bhutan developed its first Biodiversity Action Plan in 1997 as a guiding policy document for conservation and sustainable utilization of biological resources of the country. To date, Bhutan has developed and implemented three Biodiversity Action Plans- the first in 1998, second in 2002 and third in 2009 – *a guiding policy document for conservation and sustainable utilization of biological resources of the country.* In 2014, Bhutan revised and adopted the National Biodiversity Strategies and Action Plans (NBSAP) in line with global Aichi Biodiversity targets 2020 and national priorities. The Biodiversity Action Plans are "living documents" that guide conservation and sustainable utilization of biodiversity in the country and are revised every few years to evolve with the changing needs of the population and the country vis-à-vis the environment. During the course of developing the first Biodiversity Action Plan, it was recognized that responsibilities for biodiversity were divided among several units within the Ministry of Agriculture, based partly on the history of biodiversity management and partly on the distinction made between domestic and wild biodiversity, often leading to problems in coordinating, goal setting, planning and cooperation in comprehensive biodiversity management. As a result, the Action Plan recommended the institutionalization and establishment of an integrated biodiversity conservation program. This led to the establishment of the National Biodiversity Program

(NBP) in 1998 headed by a Program Manager, and with two technical programs, namely the National Herbarium and the Agro-biodiversity Program.

In 1999, the Royal Botanical Garden was established under the NBP as an *ex situ* plant conservation area and to commemorate the Silver Jubilee Celebration of the golden reign of the 4th King, His Majesty Jigme Singye Wangchuck. Subsequently in 2001, the National Biodiversity Program was upgraded to the National Biodiversity Centre as a non-departmental agency headed by a Program Director in order to strengthen conservation initiatives and coordinate biodiversity conservation and sustainable utilization programs in the country.

1.3. Different Programs established at NBC

1.3.1. Animal Genetic Resources Conservation Program

a. Ex situ conservation at the National Animal Genebank

The Animal Genebank was established in 2005 in collaboration with the Centre for Genetic Resources of the Netherlands in order to conserve the genetic pool of traditional animal breeds unique to Bhutan and of socio-cultural and economic importance. It currently holds over 10,000 doses of semen from local poultry, local cattle and sheep breeds for research and long term use. Characterization studies of production parameters and other useful economic traits will be studied through DNA mapping and selective breeding in the near future. The conserved germplasm of the traditional animal genetic resources will serve as a genetic pool for enhancing food security especially in the face of changing climate and other emerging threats.

b. In situ conservation of Animal Genetic Resources

In situ conservation activities for animal genetic resources was initiated through the GEF-UNDP Integrated Livestock and Crop Conservation Project (ILCCP) in 2008, focusing on capacity building and promotion of local diversity through value addition as well as the establishment of the Nublang Conservation Fund in collaboration with the Department of Livestock. Continued efforts are in place to mobilize resources to implement intervention strategies to strengthen *in situ* conservation of animal genetic resources and address emerging threats to the sustenance and existence of traditional animal genetic resources.

1.3.2. Plant Genetic Resources Conservation Program

a. Ex situ conservation at the National Crop Genebank

The National Crop Genebank was established in 2005 through the financial support of the Royal Government of the Netherlands and Sustainable Development Secretariat of Bhutan and currently holds a total of over 2,700 accessions of cereals, legumes, oil seeds and vegetables. Its main mandate is to carry out inventory, characterization, documentation and collection of seeds from various agro-ecological zones of the country for conservation and sustainable use of traditional plant genetic resources for food and agriculture.

b. On-farm conservation of Plant Genetic Resources

The on-farm conservation program was initiated in 2001 through the support of the Biodiversity Use and Conservation in Asia Program (BUCAP) in collaboration with RNR-RDCs and the Dzongkhag Agriculture Sector. The program works with local communities in strengthening on-farm diversity and resilience of local communities. Till date, a total of about 1500 farmers in 37 sites have been trained on conservation of genetic resources, promotion of local diversity through value addition/seed purification and broadening of genetic base through Participatory Varietal Selection (PVS).

1.3.3. Bioprospecting and Access and Benefit Sharing (ABS) Program

Under the directive of the Ministry of Agriculture and Forests, the Bioprospecting and ABS program was started in the 10th Five Year Plan to build national capacity to understand the value of Bhutan's biological resources and to explore measures to generate benefits from these resources. A well-equipped laboratory was established in 2012 and capacity was built to initiate the process of extraction of active biochemical compounds from biological resources through the support of the Bhutan Trust Fund for Environmental Conservation (BTFEC). The Access and Benefit Sharing regime was also operationalized, with NBC designated as the authorized agency to facilitate the ABS process, execute ABS agreements and Material Transfer Agreements. The documentation of Traditional Knowledge (TK) associated with biological resources was initiated in 2010 under the Bioprospecting and ABS program and completed in all 205 gewogs by January 2018.

1.3.4. Biodiversity Information Management Program

The Biodiversity Information Management Program was initiated in 2003 to coordinate documentation and dissemination of biodiversity information of the country. In 2008, under the framework of South-South Cooperation between Bhutan, Benin and Costa Rica, funded through the Royal Government of the Netherlands, NBC developed a web-based biodiversity portal, which had species information on the wild and domestic biodiversity of Bhutan. In 2013, the portal was upgraded to a national portal on biodiversity, with additional features to document and provide access to information on the biodiversity of the country more comprehensively.

In order to provide scientific vouchers to support biodiversity information, the Centre has also developed a specimen repository of invertebrate diversity of the country, through a collaborative project funded by BTFEC. Currently, the repository has collections of moths, molluscs, bees and wasps, dragonflies and damselflies, and lady beetles. In addition, the repository also holds more than 70 species of insect-fungi with about 300 specimens.

1.3.5. National Herbarium

The National Herbarium was established in 1998 under "the National Herbarium and Flora of Bhutan" project through financial support from Danish International Development Agency (DANIDA), with the main objectives to serve as the national repository and reference center for botanical collections and to coordinate plant taxonomy related studies and identify conservation priority species in the country. It became operational with basic facilities from 2000. Currently, the herbarium houses over 15,000 collections of Angiosperms, Gymnosperms, Pteridophytes and Bryophytes.

1.3.6. Royal Botanical Garden, Serbithang

The initial development of the botanical garden was supported by the Bhutan Trust Fund for Environmental Conservation (BTFEC) in 1999. The garden currently holds a living collection of more than 800 species of plants and focuses mainly on native plants. Work is underway to increase its capacity to initiate a plant rescue and restoration program as well as revenue generating initiatives.

1.4. National and international obligations

National: NBC serves as the National Focal Point for ABS and TK associated with biological resources and is the custodian of the Biodiversity Act of Bhutan 2003 and Access and Benefit Sharing Policy of Bhutan 2015. It is responsible for the operationalisation of the ABS regime and documentation of TK associated with biological resources in the country as per the Biodiversity Act Bhutan 2003. NBC also houses the national portal on biodiversity information.

International: NBC is the national focal agency for the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and the Commission on Genetic Resources for Food and Agriculture (CGRFA) and the Nagoya Protocol on ABS.

These obligations require NBC to strengthen national capacities, awareness and mechanisms to align national priorities along with the Global Plan of Action on Plant and Animal Genetic Resources for Food and Agriculture as well as to establish mechanisms on Access and Benefit Sharing in line with national priorities and in harmony with the Nagoya Protocol on ABS and to fulfill national reporting obligations. In addition, in order to coordinate and lead the development of Biodiversity Action Plans and function as a secretariat to the National Committee on Biodiversity, NBC has to be abreast of the latest developments in national and international dialogue on biodiversity management.

2. Mandates of NBC

a. To coordinate and implement biodiversity conservation and sustainable use programs in the country.

b. To coordinate and implement obligations under regional and international conventions, treaties and protocols related to biodiversity.

c. To develop policies and legal frameworks for conservation and sustainable use of biological resources.

d. To serve as the national repository for germplasm and botanical collections.

e. To serve as the national focal agency to regulate access to biological resources of the country, ensuring equitable sharing of the benefits arising from access.

f. To serve as the national focal agency for bioprospecting and documentation of traditional knowledge associated with biological resources.

g. To serve as the national clearing house for biodiversity information.

h. To promote regional and international institutional linkages and collaboration for technology transfer, technical capacity enhancement and collaborative research in the field of biodiversity.

3. Goal

To become a premier institute on biodiversity in the country resulting in the effective management of biodiversity and maximizing the benefits from it as well as contributing to international efforts toward conserving biodiversity.

4. Vision

Effective conservation, sustainable utilization and equitable sharing of benefits arising from access and use of biological resources.

5. Mission

Biological resources effectively conserved, sustainably used and benefits equitably shared for enhancement of livelihood, food security and environmental well-being of the country.

B. PLANNING TOWARDS 2030: THE NEXT 15 YEARS

1. Animal Genetic Resources Program

1.1. Brief Background

The Animal Genetic Resources (AnGR) Program was initiated in 2005 with a mandate to oversee *ex situ* and *in situ* conservation and sustainable utilization of AnGR in the country. The program has steadily grown in capabilities in animal gene banking, coordination and technical backstopping of *in situ* conservation and sustainable utilization activities of prioritized AnGR over the course of a decade. After the implementation of the Type Three project supported by the SDS fund in 2005, it was followed by the Integrated Livestock and Crop Conservation Project (ILCCP) funded by UNDP-GEF in the 10th FYP, which also upgraded the National Animal Genebank to a fully functional facility as well as supporting on farm conservation initiatives. Recent projects included the High Altitude Northern Areas of Bhutan (HANAS) project through World Bank-BTFEC support and the Asian Food and Agriculture Cooperation Initiative (AFACI) project which focused on on-farm conservation of *Jakar* sheep and value addition and improvement of AnGR in Bhutan respectively. Further, the protocol for cryopreservation of semen at the National Animal Genebank was validated through technical support from UNDP and FAO in 2011. Reports on the State of Animal Genetic Resources for food and agriculture were submitted to FAO towards formulating the Global Plan of Action for animal genetic resources in 2009 and 2010. The program is responsible for the management and collection of AnGR data (DAD-IS) and reporting on the state of AnGR in Bhutan to FAO. The Program also has a fully equipped DNA laboratory to undertake basic molecular research and refers samples for advanced genetic studies to the Animal Genetic Resources Research Center, National Institute of Animal Science and the Macrogen Inc. in Korea and the Laboratory of Racing Chemistry and the Kyoto University in Japan.

1.2. Functions

1. Assess, document and furnish status reports on animal genetic resources for food and agriculture.
2. Coordinate and implement on-farm conservation and sustainable use projects on AnGR.
3. Serve as the national repository for AnGR germplasm.
4. Develop policies and strategies for effective conservation and sustainable use of AnGR.

5. Develop protocols linking *in situ* and *ex situ* AnGR conservation programs.
6. Coordinate and implement targeted interventions for prioritized AnGR.
7. Conduct research and studies on AnGR diversity to generate required information.
8. Provide germplasm and associated information for breeding and utilization.
9. Strengthen public awareness on the importance of AnGR for food and nutrition security.
10. Promote regional and international linkages for technology transfer and effective conservation and management of AnGR.

1.3. Current Status

The AnGR program is strengthening semen collections of *nublang* (local cattle breed)*, jakar* (local sheep breed) and *sibsoo* sheep, different strains of poultry such as *yubjaanaap, belochem*, frizzle, short-legged (*baylietey*) and pigs (*saphag*). A safety back-up facility to store the duplicate samples of semen doses was established at NDRC Yusipang in 2016. Over 10,000 doses of semen in total from sheep, poultry and pig are cryopreserved. In the 11th FYP, the program also initiated DNA collection of *nublang*, yak and poultry breeds, as well as development and optimizztion of embryo collection of *nublang.*

On-farm conservation initiatives involved active engagement of local communities of Sipsoo in Samtse, Merak in Trashigang and Chumey in Bumthang for sheep; Sombaykha for *Nublang*; Gomdar in Samdrup Jongkhar and Udzorong in Trashigang for *Saphag* and Mendrelgang in Tsirang for indigenous poultry breeds to conserve pure line gene pool and increase production of local domesticated species. This has involved training on improvements in animal husbandry practices, assistance in group formation within communities, product diversification, value addition to local breeds, and exploration of incentives to promote traditional AnGR (such as the establishment of the Nublang Fund). The program also works closely with institutions including National Highland Development Center for yak conservation, College of Natural Resources for local poultry conservation, National Nublang Breeding Center for *Nublang* conservation, National Sheep Breeding Center for sheep conservation and National Dairy Research Center for activities involving embryo transfer technology and duplicate genebank.

The program has also produced a number of publications which include: *Animal Genetic Resources of Bhutan (2008), Phenotypic and genetic parameters for milk yield in traditional Nublang cattle (Bos indicus) of Bhutan (2015), Phenotypic and genetic parameters for milk yield in traditional Nublang cattle (Bos indicus) of Bhutan (2015), Immunological tolerance of Bhutanese native chicken to Infectious Bursal Disease Virus infection (2016), Assessment of genetic diversity of Mithun (Bos frontalis) population in Bhutan using microsatellite DNA markers (2017), Morphological diversity of principle horse populations of Bhutan (2017), Decline of Jakar sheep population in pastoral communities of Bhutan: A consequence of diminishing utility, alternate income opportunities and increasing challenges (2017),* and *Morphological variations of native chicken types in backyard farms of Bhutan (2017).*

Strengths

There is potential for the AnGR program to develop and implement intervention strategies to prevent the disappearance of traditional breeds of livestock and poultry due to concern from the highest authority on the decline of AnGR and the broad policy support for conservation of traditional agrobiodiversity. The public preference and demand for AnGR products in comparison to imported products also provides opportunities for the utilization of AnGR. The availability of AnGR on-farm also provides opportunities for the AnGR program to work closely with farmers to maintain/improve the utilization of AnGR. In cases where on-farm management of AnGR is not possible, the AnGR program has the capacity and mandate to carry out interventions such as the establishment of nucleus farms for traditional AnGR for prioritized breeds of livestock such as *nublang* and strains of poultry such as *belochem*, *yubjanaap* and *baylaitey*.

Weaknesses

There is a need to define clear roles and responsibilities of different stakeholders involved in animal genetic resources for food and agriculture and strengthen coordination and implementation of on-farm programs for synergistic results and to avoid duplicative efforts.

The challenges in accessibility to most areas where traditional animal genetic resources are found results in inability to tap the potential of traditional animal genetic resources products to its fullest. In some cases, the competition with high

yielding breeds also makes it economically non-viable to establish enterprises based on traditional animal genetic resources. In other cases, alternate income opportunities such as change to cash crop farming and alternate imports also results in the demise of traditional livestock breeds as is the case with *jakar* sheep in Bumthang which is almost non-existent now due to the import of synthetic yarn for weaving *yathra*. Strong religious sentiments against slaughter of animals also poses an additional challenge for conservation and sustainable utilization of AnGR especially native pig.

Other weaknesses are the lack of adequate human and financial resources to maximize the potential of animal genetic resources in the country and in certain situations, policy conflicts such as production versus conservation initiatives and the lack of sustainable measures to support *in situ* activities.

1.4. Vision

Diversity of animal genetic resources for food and agriculture maintained and sustainably used for food security and enhancement of livelihoods.

1.5. Mission

Effective conservation and sustainable utilization of AnGR for food and agriculture.

1.6. Goals

1.6.1. Short-term (2018-2023)

Goal 1: Characterization and Inventory completed and initiate monitoring

Strategy 1.1: *Conduct comprehensive characterization, inventory and documentation of traditional AnGR.*
Action 1.1.1: Assessment of minor livestock species (buffalo, goat, duck, donkey).
Action 1.1.2: Validation study of yak and sheep diversity.
Action 1.1.3: Publication (documentation) of the findings.

Strategy 1.2: *Strengthen information and knowledge base on traditional AnGR.*
Action 1.2.1: Provide access to information on phenotypes (morphology, production traits), genotypes and phylogeny (Genotypes and DNA sequences) online.
Action 1.2.2: Provide information of bio-molecular profile of products from traditional AnGR.

Strategy 1.3: *Monitoring of population status and diversity of traditional AnGR.*
Action 1.3.1: Institute breed-based livestock census in collaboration with DoL.
Action 1.3.2: Periodic assessment of genetic diversity and inbreeding.

1.6.2. Mid-term (2023-2028)

Goal 2: Strengthen sustainable use and development of traditional AnGR.

Strategy 2.1: *Prioritization and development of management plan.*
Action 2.1.1: Develop a decision making tool for prioritization (based on genetic uniqueness, economic traits, adaptability traits, disease resistance, socio-cultural importance and risk status).
Action 2.1.2: Develop breed specific management plans (optimum population and diversity) in nucleus farms and *in situ* conservation sites for prioritized traditional AnGR.

Strategy 2.2: *Capitalize on special values/traits of traditional AnGR.*
Action 2.2.1: Identification of socio-economically important traits.
Action 2.2.2: Profiling of special values (nutritional, therapeutic, nutraceuticals) of traditional AnGR products.
Action 2.2.3: Promote (incentives/subsidy) development of niche products.
Action 2.2.4: Source funds to initiate/expand sustainable use projects.

Strategy 2.3: *Initiate improvement of productivity of traditional AnGR.*
Action 2.3.1: Coordinate animal identification and performance recording.
Action 2.3.2: Coordinate selective breeding for improved production performance.

Strategy 2.4: *Strengthen capacity for sustainable utilization of traditional AnGR.*
Action 2.4.1: Increase the strength of professional staff to coordinate, support and monitor.
Action 2.4.2: Build staff capacities in research, value addition, product development, marketing etc. of traditional AnGR.
Action 2.4.3: Develop/strengthen collaborations/partnerships with relevant stakeholders (Commodity programs under DoL, Dzongkhag Livestock Sectors and Gewog extension offices) to promote sustainable utilization of traditional AnGR.

1.6.3. Long-term (2028-2033)

Goal 3: Effective management of traditional AnGR (2028-2033)

Strategy 3.1: *Promote in situ conservation sites.*
Action 3.1.1: Formation of breeder groups/associations.
Action 3.1.2: Recognition of *in situ* conservation sites/custodians/products (site-heritage sites, farmers-breed custodian/guardian, product-Geographical Indication).

Strategy 3.2: *Preparedness for mitigation of breed loss risks*.
Action 3.2.1: Maintain adequate number of doses semen/embryos and diversity in Animal Genebank for threatened AnGR.
Action 3.2.2: Capacity development in reproductive technologies (Artificial Insemination and Embryo Technology).

2. Plant Genetic Resources (PGR) Program

2.1. Brief Background

The PGR program was initiated in 1998 as the Agrobiodiversity Conservation (ABC) program for the conservation and sustainable use of Plant Genetic Resources for Food and Agriculture (PGRFA) in the country considering the decline of traditional crop diversity in the country due to many complex factors namely urbanization, displacement of crop varieties, change in cropping system, etc. The on-farm conservation of PGRFA was initiated in 2001 with BUCAP project supported by Southeast Asia Regional Initiatives for Community Empowerment (SEARICE) followed by the Integrated Livestock and Crop Conservation Program (ILCCP) project in 2007 with funding support from UNDP-GEF. These projects focused on the promotion of traditional PGRFA through crop improvement, Participatory Varietal Selection (PVS), product development, value addition and marketing and establishment of Community Seed Banks (CSBs).

The *ex situ* conservation of PGRFA was initiated after the establishment of the National Plant Genebank through funding support from the Royal Government of Netherlands under the Framework of Sustainable Development Agreement in 2005 with international standard protocols which was further validated through technical assistance from Food and Agriculture Organization (FAO) in 2013.The safety duplicate facility at ARDC Wengkhar was established in 2015 with funding support from European Union Sector Support Project (EUSSP) to mitigate the risk of loss of genebank collections to natural or man-made catastrophes in the Genebank. Further in 2016, the Genebank was upgraded with the establishment of In vitro and Cryo-preservation facilities with financial support from EU-GCCA for the conservation of horticultural crops and those crops that are propagated vegetatively.

Similarly, a project on diversification and crop improvement of rice was implemented under the framework of International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) benefit-sharing fund from 2013 to 2014 and the HANAS project funded by BTFEC (2014-2017) supported on-farm conservation of finger millet through product development and value addition. In addition, the Genetic Resources Policy Initiative (GRPI II) project supported policy, awareness, capacity building and research work on the implementation of the ITPGRFA and the Multilateral System (MLS) from

2013 to 2015. Subsequently the National Plant Genebank also implemented the Integrated Management of Plant Genetic Resources project (IMPGR) (2016-2017) supported by AFACI, focusing on phenotypic characterization of rice and capacity building of genebank staff.

2.2. Functions

a. Assess, document and status reporting of plant genetic resources for food and agriculture.
b. Coordinate and implement on-farm conservation and sustainable use programs of plant genetic resources for food and agriculture.
c. Serve as the national repository for PGRFA germplasm.
d. Develop policies and strategies for effective conservation and sustainable use of PGRFA.
e. Develop protocols linking *in situ* and *ex situ* PGRFA conservation programs.
f. Coordinate and implement targeted interventions for prioritized PGRFA.
g. Conduct research and studies on PGRFA diversity to generate required information.
h. Provide germplasm and associated information for breeding and utilization.
i. Promote public awareness on the importance of plant genetic resources for food and agriculture for food and nutrition security.
j. Promote regional and international linkages for technology transfer and effective conservation and management of plant genetic resources for food and agriculture.

2.3. Current Status

Currently, the National Plant Genebank houses over 2700 accessions of crop genetic resources comprising cereals, legumes, oilseeds, some vegetables and a few forages, collected from all agro-ecological zones and the safety back-up facility in ARDC Wengkhar houses over 2500 accessions of duplicate samples. *Ex situ* activities under the program include gap filling of germplasm collection, characterization of accessions and initiating conservation through *in vitro* and cryopreservation methods. Further the PGR program has initiated *in vitro* and Cryopreservation work on some recalcitrant crops (potato, garlic, and banana). An inventory on agrobiodiversity in the country initiated in the 11th FYP is due to be completed by the end of the 11th FYP.

On-farm conservation initiatives have established a total of 37 on-farm conservation sites across the country promoting conservation and use of traditional crop varieties through PVS, crop improvement, rehabilitation, value addition and capacity building of farming communities.

Two drought tolerant rice varieties, *Zangthi* and *Bhur Kamja* were promoted in the on-farm conservation sites in the 11th FYP. The first Community Seed Banks (CSBs) were established in Gomdhar and Phuntshothang in 2007 followed by Bhur and Bumthang in 2009 and 2011 respectively. Two more CSBs were recently established in Dewathang through the Samdrup Jongkhar Initiative (SJI) and in Buli by the community.

Till date the implementation of PGRFA conservations activities also produced a number of publications which are *Plant Genetic Resources: Bhutanese Perspective (2000), Plant Genetic Resources of Bhutan, Volume I: Field Crops (2008), Biodiversity Use and Conservation in Asia Program (BUCAP) 2002-2010 (2011), History of important food crops in Bhutan (2015), Harvests: Farmer's success stories (2016) and the National Cereals Conservation Strategic Action Plan (2016).*

Strengths

Although the diversity of traditional crop varieties is on the decline in some areas/districts, majority of the farming communities still continue to cultivate huge diversity of traditional crop varieties which can be collected and conserved in the Genebank. Having the *ex situ* and the on-farm conservation under the same program complements each other ensuring effective conservation and use of PGRFA. Factors like climate change, nutritional needs of people and concern from higher authorities for the decline in crop diversity encourages the cultivation of traditional crop varieties by farming communities. The Genebank serves as a source of genetic resources for researchers and rehabilitation of varieties in farmer's field promoting the use of traditional PGRFA.

Increasing community awareness and understanding on the importance of PGRFA diversity and initiatives towards use of traditional PGRFA by the farming communities promotes its conservation and sustainable use. The National Plant Genebank has strong linkages with international and regional genebanks for transfer of knowledge and technologies.

Weaknesses

Conservation of plant genetic resources in Bhutan is generally challenging due to limited financial and human resources, policy conflicts and developmental activities. On the technical aspect, the lack of technical capacity in molecular characterization of crop germplasm delays the diversity assessment of the accessions in the Genebank. Further *ex situ* conservation of horticultural crops requires specialization and the lack of adequate technical expertise in the field makes it difficult to implement these activities. Lack of a reliable and sufficient supply of LN2 restricts cryo-preservation activities. On-farm conservation of PGRFA is impeded mainly due to the lack of awareness on importance of crop diversity by farming communities, absence of policy guidance and limited resources to expand on-farm conservation activities in order to make traditional crop farming economically viable and sustainable.

2.4. Vision

Diversity of plant genetic resources for food and agriculture maintained and sustainably used for food security and enhancement of livelihoods.

2.5. Mission

Effective conservation and sustainable utilization of PGR for food and agriculture.

2.6. Goals

2.6.1. Short-term (2018-2023)

Goal 1: On-farm/*in situ* PGRFA diversity information made available.

Strategy 1: *Comprehensive assessment of on-farm diversity of cereals and horticultural crops.*
Action 1.1.1: Publication of status of on-farm cereal and horticulture crops diversity.
Action 1.1.2: Identify priority areas and crops for targeted on-farm and *in situ* conservation of PGRFA.
Action 1.1.3: Initiate community biodiversity register to maintain local crop diversity and associated knowledge at the Gewog level.

Strategy 2: *Comprehensive assessment of Crop Wild Relatives (CWR).*
Action 1.2.1: Conduct eco-geographic inventory on CWR.
Action 1.2.2: Formulate action plan for conservation and sustainable use of CWR.
Action 1.2.3: Publication of status of CWR diversity based on field verification.

Goal 2: Conservation and sustainable use of PGRFA diversity strengthened.

Strategy 1: *Strengthen on-farm conservation and sustainable use of neglected and underutilized species (NUS).*
Action 2.1.1: Conduct monitoring of on-farm sites established in the past.
Action 2.1.2: Source financial support for on-farm conservation of NUS.
Action 2.1.3: Implement on-farm conservation initiatives of NUS.
Action 2.1.4: Conduct Evolutionary Plant Breeding (EPB), Participatory Plant Breeding (PPB), value addition, product development & marketing of NUS.

Strategy 2: *Support, recognize and mainstream informal or farmers' traditional seed systems.*
Action 2.2.1: Improve and strengthen farmers' seed systems using scientific techniques to improve seed quality and productivity.
Action 2.2.2: Recognize and reward farming communities for their contribution to PGRFA conservation and persistence.
Action 2.2.3: Strengthen Community Seed Banks (CSB).

Strategy 3: *Enhance education and awareness on PGRFA.*
Action 2.3.1: Develop advocacy, education and awareness materials for general public, research academia, extension personnel, policy makers, farmers and others on PGRFA.
Action 2.3.2: Continue conducting awareness programs and campaigns on the importance and value of PGRFA diversity and nutrition for farmers, students, policy makers and general public.

2.6.2. Mid-term (2023-2028)

Goal 3: PGRFA diversity secured.

Strategy 1: *Conduct targeted germplasm exploration of PGRFA for ex situ conservation.*

Action 3.1.1: Conduct gap assessment and prioritize collection of germplasm based on crop, location and distribution.
Action 3.1.2: Continue supporting targeted collection of orthodox crops.
Action 3.1.3: Conduct *ex situ* conservation of CWR.

Strategy 2: *Phenotypic and genetic variability studies conducted on genebank accessions.*
Action 2.2.1: Complete phenotypic and genetic variability studies on conserved PGRFA.
Action 2.2.2: Screen and evaluate *ex situ* conserved germplasm in collaboration with stakeholders.

Strategy 3: *Strengthen on-farm/ in situ conservation of underutilized PGRFA and CWR.*
Action 3.3.1: Source funds for on-farm/*in situ* conservation of underutilized PGRFA and CWR.
Action 3.3.2: Conduct studies, generate information, and create awareness for conservation and utilization of underutilized PGRFA.
Action 3.3.3: Identify and initiate *in situ* conservation of CWR in collaboration with stakeholders.

2.6.3. Long-term (2028-2033)

Goal 4: On-farm/*in situ* diversity and genetic erosion of PGRFA monitored over time and space.

Strategy 1: *Monitoring of on-farm diversity and genetic erosion over time and space.*
Action 4.1.1: Design on-farm diversity monitoring system.
Action 4.1.2: Carry out diversity and genetic erosion monitoring over time and space.
Action 4.1.3: Prepare status report after every 10 years.

Goal 5: On-farm conservation and sustainable use of PGRFA diversity including CWR strengthened.

Strategy 1: *Strengthen on-farm conservation and sustainable use of PGRFA.*
Action 5.1.1: Fund mobilization for on-farm conservation initiatives.

Action 5.1.2: Conduct EPB, PVS, PPB, value addition, product development and marketing.

Strategy 2: *Strengthening of in situ conservation for CWR.*
Action 5.2.1: Strengthen *in situ* conservation sites/Genetic reserves in collaboration with relevant stakeholders.
Action 5.2.2: Institute *in situ* diversity monitoring system for CWRs.

Goal 6: *Ex situ* conservation expanded to recalcitrant crops and CWR and sustained.

Strategy 1: *Conduct targeted germplasm exploration of recalcitrant crops for ex situ conservation.*
Action 6.1.1: Upgrade/strengthen genebank equipment and facilities.
Action 6.1.2: Support targeted collection of recalcitrant crops.
Action 6.1.3: Strengthen field Genebanks at ARDCS.
Action 6.1.4: Initiate DNA bank.

Strategy 2: *Maintain and sustain ex situ accessions of recalcitrant crops and CWR.*
Action 6.2.1: Carry out germplasm monitoring as per standard genebanking protocols.
Action 6.2.2: Facilitate distribution of germplasm from Genebank to researchers and farmers.
Action 6.2.3: Strengthen safety duplicates facilities and monitor safety back-up accession.

3. Bioprospecting and ABS Program

3.1. Brief Background

The Bioprospecting and ABS program was initiated in 2009 during the 10th FYP under the directive of the Ministry of Agriculture and Forests. It was established with the rationale to build national capacities to understand the value of Bhutan's biological resources and to explore measures to generate benefits from these resources. The program focuses mainly on biodiscovery research and Access and Benefit Sharing. The program received technical assistance and guidance from Nimura Genetics Solution (NGS) in the initial phase of the program and signed three Memorandum of Agreements (MoA) with NGS, Quantum Pharmaceutical Limited (QPL) and Bhutan Pharmaceutical Private Limited (BPPL) in the 10th FYP. In the 11th FYP, two ABS agreements were executed with Chanel Parfums Beaute (CPB) and Shin Nippon Biomedical Laboratories Ltd. (SNBL). Two tripartite ABS agreements were executed with local communities of *Jom Dagam Ngomen Tshogpa, Namther Menrig Tshogpa*, Menjong Sorig Pharmaceuticals Corporation Ltd. (MSPCL), Bio-Bhutan and NBC. Further, one more ABS agreement was executed between NBC and the local community of Loggchina gewog (*Dzedokha Phacheng Detshen*).

The Bhutan Access and Benefit Sharing (BABS) Fund was established as a plough-back funding mechanism in 2010 to receive monetary benefits accrued from access to genetic resources or its associated traditional knowledge and support biodiversity conservation initiatives. The Bioprospecting laboratory was established through the Bioprospecting project supported by BTFEC with a fund of USD 300,000. The program was further strengthened in terms of legal frameworks, capacity development, awareness raising, infrastructure up-gradation and piloting ABS projects through a funding support of USD 1.1 million from the UNDP-GEF project on implementing the Nagoya Protocol on Access to Genetic Resources and Benefit Sharing in Bhutan. In addition, funding support of USD 61,000 from Genetic Resources Policy Initiatives (GRPI II) project of Biodiversity International focused on raising awareness on ABS and assisting in ABS policy formulation. NBC also received technical and committed funding support of USD 199,000 from Chanel Parfums Beaute as a research grant towards national capacity development and research on potential biological resources.

3.2. Functions

a. Document, protect and appropriately utilize TK associated with biological resources.
b. Conduct exploration and research on biological resources of the country for natural product development and biodiscovery.
c. Implement the National Access and Benefit Sharing Policy.
d. Promote innovative measures to encourage people-centric conservation (e.g. Bhutan Access and Benefit Sharing Fund, Community based natural resource management initiatives, etc.).
e. Provide technical inputs for developing policies and protocols on conservation and sustainable use of biological resources and associated Traditional Knowledge.
f. Provide technical backstopping for the execution of contract agreements, Material Transfer Agreement, awareness raising programs, etc.
g. Promote regional and international linkages for collaborative work in the field of bioprospecting and access and benefit sharing.

3.3. Current Status

A Bioprospecting laboratory with state of the art equipment for basic plant analysis was established in 2012 and has built a collection of more than 1200 plant extracts to date. Requisite technical capacities were also developed to initiate basic biodiscovery research focused on plant extraction and natural product development through the support of the BTFEC. The ABS regime has been institutionalized with the NBC designated as the National Focal Point to facilitate access to genetic resources and associated TK. Till date, the Centre has executed over a 100 Material Transfer Agreements (MTA) and eight ABS agreements; and developed ten natural products based on ABS principles. The ABS Policy of Bhutan 2015 has been developed and adopted by the Cabinet, and the Biodiversity Act of Bhutan 2003 has been revised and submitted to the Cabinet Secretariat for further submission to the Parliament. Furthermore, the first Interim National Report on Implementing Nagoya Protocol in Bhutan was submitted to the CBD Secretariat in 2017.

The BABS Fund has received around Nu. 4.5 million as part of the monetary benefits generated through ABS agreements as well as private contributions. The inventory and the documentation of TK associated with biological resources has also been completed in all 205 Gewogs.

Strengths

The Bioprospecting and ABS program has an advantage in biodiscovery research compared to conventional research in discovering/identifying potential active compounds for product development due to its inventory and documentation of TK associated with biological resources. Despite Bhutan's rich biodiversity and associated TK, there has been limited biodiscovery work carried out till now thereby offering more opportunities for successful outcomes from bio-exploration and biodiscovery work.

The program has well-established linkages and collaborations with national/ international organizations to enable progressive advancement. Harmonized legal and regulatory frameworks on ABS coupled with the commitment and support of the government, local communities and policy makers strengthens the implementation of the ABS regime. As the designated national focal agency for the documentation and protection of TK associated with biological resources, the program has completed the national inventory, which will guide the biodiscovery program.

Weaknesses

Human resource constraint is a major weakness with only one person operating the Bioprospecting Laboratory since its establishment, supported by contract recruits based on the availability of funds. Lack of adequate technical capacities is also a major weakness in accelerating bio-exploration and biodiscovery work such as lack of expertise in phytochemistry and lack of equipment such as Mass Spectrometry.

3.4. Vision

To become a Centre of excellence in biodiscovery research and implementation of Access and Benefit Sharing regime for conservation and sustainable use of Bhutan's biodiversity.

3.5. Mission

To add value to biological resources and facilitate access to genetic resources ensuring fair and equitable sharing of benefits to the users/providers.

3.6. Goals

3.6.1. Short-term (2018-2023)

Goal 1: Strengthen national capacities on phytochemical analysis and ABS implementation.

Strategy 1: *Strengthen current bioprospecting laboratory into a phytochemical analytical laboratory.*
Action 1.1.1: Enhance phytochemical analysis capacities and infrastructure.
Action 1.1.2: Establish institutional collaborations with renowned phytochemical laboratories.
Action 1.1.3: Source funds to support biodiscovery research.

Strategy 2: *Strengthen institutional, legal and administrative measures for the implementation of ABS.*
Action 1.2.1: Adopt the Biodiversity Bill.
Action 1.2.2: Review and adopt the draft Biodiversity Regulations.
Action 1.2.3: Review and strengthen the existing ABS monitoring network.
Action 1.2.4: Strengthen national capacities on TK, ABS, Intellectual Property (IP), Community Protocols, documentation of Customary Practices, Negotiations, Contract Agreements, etc.

Strategy 3: *Strengthen awareness on ABS.*
Action 1.3.1: Develop appropriate awareness (CEPA - Communication, Education and Public Awareness) material.
Action 1.3.2: Promote awareness on ABS, TK and Customary Practices for the general public, policy makers, academia, private sector and the local communities.

Strategy 4: *Become a repository on Traditional Knowledge (TK) associated with biological resources and Customary Practices relevant to Biodiversity conservation and sustainable use.*
Action 1.4.1: Assess and recommend measures for preservation, protection and utilization of TK associated with biological resources.
Action 1.4.2: Strengthen measures to prevent misappropriation of TK associated with biological resources and Customary Practices.
Action 1.4.3: Regulate access to TK associated with biological resources.

3.6.2. Mid-term (2023-2028)

Goal 2: Provide services on phytochemical analysis and promote ABS.

Strategy 1: *Promote in-country research and commercial utilization of Bhutan's biological resources and associated TK through technology transfer and collaborative research.*
Action 2.1.1: Publish peer-reviewed papers on phytochemistry of biological resources.
Action 2.1.2: Generate chemical profiling reports of plants associated with unique TK.
Action 2.1.3: Screen and conduct scientific validation of the potential TK associated with biological resources.
Action 2.1.4: Explore innovative measures to strengthen and incentivize TK and Customary Practices that promote biodiversity conservation and sustainable use.

Strategy 2: *Strengthen the implementation of a fair and equitable ABS model*.
Action 2.2.1: Explore and promote ABS ventures at local, national and international levels.
Action 2.2.2: Monitor ABS agreements.
Action 2.2.3: Empower communities on ABS negotiations.

Strategy 3: *Strengthen the BABS fund for empowering local communities to engage in biodiversity conservation.*
Action 2.3.1: Explore innovative measures to strengthen BABS fund.
Action 2.3.2: Support community based biodiversity conservation initiatives.

3.6.3. Long-term (2028-2033)

Goal 3: Become a leading Centre for biodiscovery research and implementation of ABS.

Strategy 1: *Provide services on phytochemical analysis.*
Action 3.1.1: Generate research and development data for biodiscovery research.
Action 3.1.2: Complete the phytochemical analysis of identified TK plants/endemic plants.

Strategy 2: *Maximize the benefits from ABS.*

Action 3.2.1: Leverage potential biological resources with unique associated TK to execute ABS agreements with maximum benefits.

Action 3.2.2: Explore and increase the number of community based conservation initiatives and ABS agreements.

Action 3.2.3: Enhance international cooperation on ABS.

Action 3.2.4: Strengthen the capacity of the BABS fund to support biodiversity conservation and sustainable use initiatives.

4. Biodiversity Information Management Program

4.1. Brief background

Easy access to updated and comprehensive Biodiversity information is fundamental for research, decision-making, policy advice and monitoring of the biodiversity status and the effectiveness of conservation measures. Biodiversity data and information are generated by many stakeholders. However, these data and information are not easily accessible mainly due to the lack of a common sharing platform, which results in either duplication of efforts or underutilization of the existing data. Cognizant of these issues on biodiversity data and information, the National Biodiversity Centre initiated the program on Biodiversity Information Management as early as 2003. However, due to other competing priorities as well as lack of advancement in information technology and staff, not much progress was made then. With the advancement of information technology and the potential it offered to address issues in managing biodiversity information as well as the increasing need for biodiversity data and information in the country, the National Biodiversity Centre developed a web-based biodiversity portal in 2008, with support from South-South Cooperation Project and strengthened the program on Biodiversity Information Management. The portal was subsequently upgraded to the status of a national biodiversity information clearing house in 2010. However, because of the vastness and variety of biodiversity data, it was not feasible for a single agency to collect as well as curate this vast data.

Thus, in 2013, a consortium with membership from all relevant biodiversity data generator and user stakeholders was formed, with Biodiversity Information Management Program of NBC as Secretariat to the Consortium. The initiative of the consortium was also to address the issue of duplicative efforts in developing and managing isolated information systems and databases.

The improved version of the Biodiversity Portal developed through funding support from RGoB, DANIDA (Bhutan Climate Summit project) and EU-SSP project was launched in December 2013. Basic capacity of the data curators in curating the data in the improved version of the portal was developed through funding support from DANIDA and EU-GCCA project from 2014 to 2016. From September 2014, the program also implemented a BTFEC funded project amounting to Nu. 9.576 million for a period of three years to document selected groups of invertebrates in the country and establish invertebrate reference

collections, in collaboration with the Naturalis Biodiversity Centre in the Netherlands, Ugyen Wangchuck Institute for Conservation and Environmental Research (UWICER), Royal Society for Protection of Nature (RSPN), Sherubtse College, College of Natural Resources (CNR), and National Plant Protection Centre (NPPC).

Some of the other cross-cutting activities coordinated and implemented by the program over the years include the following:

- Preparation of a report and a National Information Sharing Mechanism on the implementation of the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture in Bhutan funded through Regional FAO project (USD 14,000) from July 2010 to December 2011.
- Preparation of a National Action Plan on Biodiversity persistence and climate change for the *Climate Summit for a Living Himalayas - Bhutan 2011*, where four countries namely, Bangladesh, Bhutan, India and Nepal agreed upon a regional 'Framework of Cooperation' aimed at building regional resilience to the negative impacts of climate change in the Himalayas.
- Preparation of the National Report on the State of Biodiversity for Food and Agriculture prepared for the Commission on Genetic Resources for Food and Agriculture to the FAO from 2015-2016.
- Formulation of the National Biodiversity Strategies and Action Plan (NBSAP) 2014 through GEF-UNEP funded project amounting to USD 180,000 from 2014 to 2016.

4.2. Functions

a. Serve as national clearing house/reference Centre for biodiversity information.
b. Coordinate initiatives to increase biodiversity information of the country with improved access to it for research, decision-making, policy advice and monitoring of biodiversity conservation and effectiveness of conservation measures.
c. Coordinate implementation and status reporting of obligations under national, regional and international conventions/treaties/protocols including NBSAP(s).
d. Coordinate and facilitate development of biodiversity databases and

online repository, publications and information products, including provision of ICT services of the centre.

4.3. Current Status

Currently, the Biodiversity Information Management Program is managed by two regular technical staff, two support staff and one international volunteer. The web-based biodiversity portal (www.biodiversity.bt) acts as an official repository of information on Bhutan's biodiversity, and currently has provisions to provide biodiversity information of the country through the following modules:

a. Species page: Curated species information.
b. Observation page: Citizen-science based species observation information.
c. Documents page: All documents related to biodiversity of Bhutan.
d. Map module: Biodiversity related data in the form of map.
e. Datasets: All data tables and lists.

As a strategy to increase biodiversity data, the program collaborates with partner organizations such as College of Natural Resources, Sherubtse College, UWICER, NPPC, RSPN, WWF, etc., and coordinates implementation of joint-project for data generation and documentation of biodiversity, specifically of lesser known groups such as invertebrates and aquatic biodiversity. The collaborative activities till date have resulted in the following publications on lesser known invertebrates, namely, *A Field Guide to the Common Bees and Wasps of Bhutan (2017); A Field Guide to the Common Lady Beetles of Bhutan (2017); A Field Guide to the Common Dragonflies and Damselflies of Bhutan (2017); A Field Guide to the Common Moths of Bhutan (2017)* and *A Field Guide to the Common Molluscs of Bhutan (2017)* and more than 25 scientific papers were published in national and international journals. Additionally, several species new to science were also discovered including a new dragonfly species, Gyalsey Emerald Spreadwing *(Megalestes gyalsey)*, named in honor of the Crown Prince of Bhutan, the Gyalsey Jigme Namgyel Wangchuck in 2017. Apart from strengthening and managing the portal and collaborative activities, the program also manages the national invertebrate specimen repository and the library.

Currently, the program has international collaborations with the Naturalis Biodiversity Center of the Netherlands for invertebrate diversity documentation and India Biodiversity Portal for technical support to the portal. Since June

2017, for a period of one year, the program is also implementing the World Bank (USD 50,000) and WWF (USD 36,000) supported projects to strengthen the features of the portal to incorporate aquatic biodiversity data and develop the capacity of the data curators.

Strengths

Bhutan Biodiversity Portal as the only web-based portal covering all groups of biodiversity has the potential to host and provide comprehensive information on biodiversity of the country. With the functionality of the portal to engage citizens, it has the potential to widen citizens' involvement in biodiversity research (documentation, data contribution, curation, analysis, long-term monitoring, etc.). Further, as the program has a well-established technical collaboration with the India Biodiversity Portal, the program can make the portal dynamic to address the needs of different user groups and stakeholders. The program also has the potential to promote awareness and appreciation of biodiversity, especially by youth, through use of contemporary technology e.g. Mobile Applications for the portal. Furthermore, as the portal holds information on all groups of biodiversity, the program has overview of the information status and thus can provide guidance to prioritize research and documentation needs in specific groups and avoid duplication of efforts.

Weaknesses

Lack of dedicated software developer/Information Communication Technology (ICT) personnel to provide continuity and sustainability in the development of biodiversity information management tools, e.g. Portal, Mobile Apps, etc. is an ongoing issue.

Inadequate financial and technical resources to keep up with rapid technological advancement in ICT in order to keep the portal updated and dynamic is also a challenge. Lack of sustained funding to meet the evolving needs of different user groups also constrains the progressive growth of the program.

4.4. Vision

A one-stop national repository of reliable, easily accessible and interactive biodiversity information.

4.5. Mission

To provide easy access to comprehensive, reliable and updated biodiversity information of the country for enhanced understanding of biodiversity dynamics in space and time.

4.6. Goals

4.6.1. Short-term: 2018-2023

Goal 1: 30[1] percent of the available biodiversity information curated and accessible through the portal.

Strategy 1: *Strengthen data, information and functionality of the Bhutan Biodiversity Portal.*
Action 1.1.1: Complete curation of species page information for higher Plants and Mammals.
Action1.1.2: Incorporate other isolated biodiversity databases into the portal. E.g. National Herbarium database, Botanical Garden's collection database, etc.
Action1.1.3: Increase data contributor and user base.
Action1.1.4: Initiate additional data generating initiative e.g. biological inventory based on spatial and taxonomic data gaps.
Action1.1.5: Develop additional features and functionality of the portal based on user demand.
Action 1.1.6: Publish annual biodiversity statistics through the portal.
Action1.1.7: Strengthen/improve accessibility to biodiversity publications.

Strategy 2: *Build capacities in documentation and management of biodiversity information and awareness.*
Action 1.2.1: Strengthen capacities in biodiversity information management (E.g. data curation, GIS, data harvesting from various sources, data analysis, software/ application development, etc.).
Action 1.2.2: Increase awareness on BBP as a tool for data documentation and consolidation as well as data source.

[1] 30 percent refers to species information of higher plants and mammals currently available

Goal 2: National reference collections for invertebrate biodiversity strengthened.

Strategy 1: *Strengthen capacity in the management of invertebrate reference collections.*
Action 2.2.1: Recruitment of curator for invertebrate reference collections.
Action 2.2.2: Improve curatorial skills and management of invertebrate reference collections and related information.
Action 2.2.3: Increase reference collections of invertebrates.

Goal 3: BBP Consortium and NBSAP secretariats strengthened and functional.

Strategy 1: *Strategic engagement of stakeholders and partnership building to generate biodiversity data and implement cross-cutting programs.*
Action 3.1.1: Develop programs to engage stakeholders and build partnership for collaborative data generating projects.
Action 3.1.2: Improve institutional capacity to coordinate NBSAP implementation and functioning of the National Committee on Biodiversity.

Strategy 2: *Explore funds, and develop national and international institutional linkages.*
Action 3.2.1: Explore funding windows to develop, expand and sustain the biodiversity information program and achievement of NBSAP targets.
Action 3.2.2: Explore and develop collaborative and mutually beneficial projects and programs with relevant national and international institutions.

4.6.2. Mid-term (2023-2028)

Goal 4: 50 percent of the available biodiversity information curated and accessible through the portal.

Strategy 1: *Continue strengthening data, information and functionality of the Biodiversity Portal.*
Action 4.1.1: Expand data curator base and strengthen their role and contribution in data curation in the portal.
Action 4.1.2: Complete curation of species page information for other groups under study.

Action 4.1.3: Strengthen data generating initiatives (e.g. continue biological inventory projects).
Action 4.1.4: Strengthen technical capacity in portal feature development and management (e.g. applications development, back-end portal management).
Action 4.1.5: Develop additional functionality based on emerging needs and user demand (e.g. Interactive species distribution models; species richness; interactive taxonomic keys).

Goal 5: National reference collections for other under-studied groups of biodiversity established.

Strategy 1: *Expand national reference collections of other under-studied groups of biodiversity.*
Action 5.1.1: Develop infrastructure to accommodate reference collections of other groups.
Action 5.1.2: Develop curatorial skills of other groups of biodiversity.
Action 5.1.3: Expand collaboration with national, regional and international organizations on under-studied groups of biodiversity.

4.6.3. Long-term (2028-2033)

Goal 6: Bhutan Biodiversity portal used as an information source for policy decisions and actions on biodiversity.

Strategy 1: *Strengthen biodiversity data and features in the portal.*
Action 6.1.1: Continue data generating initiatives with focus on data deficient biodiversity groups.
Action 6.1.2: Expand portal functionality and features to include other environmental data (e.g. watershed and river tributaries, soil, hydropower, pollution, etc).

Strategy 2: *Strengthen access to updated policy information products.*
Action 6.2.1: Enhance capacity to translate data into policy information products.
Action 6.2.5: Ensure availability of updated policy information products.

5. National Herbarium (THIM)[2]

5.1. Brief Background

The need for a herbarium in the country was recognized with the implementation of the nationally significant Flora of Bhutan project in the early 1970s, when major botanical collections and expeditions were initiated. The key achievements of the flora project are collections of representative herbarium specimens and commencement of publications on the Flora of Bhutan. The specimens collected were mainly deposited at the renowned international herbaria of the Royal Botanic Garden Edinburgh, the Royal Botanic Garden Kew, the British Museum (Natural History), Tokyo University and Indian Botanic Garden, although the duplicates were retained in the herbarium under the then Department of Forests. Later in 1987, the herbarium was shifted to the Forestry Research Centre at Taba. However, several specimens deteriorated due to lack of proper storage facilities.

Finally, it was moved to the present location at Serbithang under the National Biodiversity Centre. In 1998, the "National Herbarium and Flora of Bhutan project" was initiated with financial support from DANIDA. The National Herbarium was established and publication of three volumes comprising nine books on the Flora of Bhutan was completed. In 2003, the National Herbarium became operational with basic facilities and the Flora of Bhutan publications were completed with financial support from DANIDA. In addition, capacity was built in the fields of botany, taxonomy and herbarium techniques and national and international collaborations were developed.

The collection of representative specimens was prioritized to strengthen explorations, collections and documentation of the floristic diversity in the country through several botanical projects namely the:

a. Bhutan Fern project was implemented during the 9th FYP and resulted in a collection of 2539 specimens. A checklist of 411 species was published.
b. Pilot project on invasive plant species of Bhutan was implemented in 2008-2009 with funding support under the framework of the Program for South-South Cooperation (PSC) between Benin, Bhutan and Costa Rica.
c. Comprehensive assessment of climate change impacts on endemic plant diversity along the bio-geographic elevation gradients in four eco-floristic

[2] THIM is the official acronym assigned to the National Herbarium of Bhutan in the directory to the world's herbaria, Index Herbarium

zones in Bhutan with funding support from the BTFEC from 2012-2015.

d. Impact assessment of invasive plants in Bhutan was conducted as one of the project components under EU-GCCA project.
e. Red listing of Bhutan's Endemic Plant Species was implemented from 2014-2015, in collaboration with the Biodiversity Network Japan (BDNJ) with financial support from Toyota Motors, Japan and technical support from IUCN.
f. Biodiversity conservation and sustainable use in HANAs (High Altitude Northern Areas of Bhutan) was implemented from 2015-2017 through funding support from the BTFEC.

5.2. Functions

a. Serve as the national botanical repository and reference centre.
b. Strengthen botanical information and knowledge base through exploration, collection and documentation of plant diversity in the country and digitization of collections.
c. Provide plant taxonomic facilities, trainings and services for proper identification and botanical research.
d. Coordinate plant taxonomy and floristic researches and identify conservation priority species in the country.
e. Promote regional and international linkages for collaborative work in the fields of botany and taxonomy.

5.3. Current Status

Currently, the National Herbarium houses over 15,000 specimens mostly of vascular plants classified according to the Engler and Prantl system of classification. The collections include angiosperms, gymnosperms, pteridophytes (ferns and allies) and bryophytes (mosses and liverworts) of Bhutan.

Facilities and capacity on herbarium techniques were established with international standards. The program also provided technical support and basic facilities for the establishment of four field herbaria in the protected areas of Sakteng Wildlife Sanctuary (Tashigang), Bumdeling Wildlife Sanctuary (Trashiyangtse), Wangchuck Centennial National Park (Bumthang) and Jigme Dorji National Park (Gasa) through financial support from the BTFEC. In addition to the *Flora of Bhutan*, the Checklist of Bhutanese Ferns - *Pteridophytes of Bhutan (2009)*, the handbook on the *Plants Endemic to Bhutan Himalaya (2015)*, and the checklist of the HANAs flora - *Alpine Plants*

of Bhutan Himalaya (2017) were published. Four plant species new to science namely, *Meconopsis gakyidiana* (revision and up-gradation of National Flower to species level), *M. merakenis, M. elongata* and *Roscoea megalantha* were discovered and described.

Strengths

The National Herbarium has the potential to lead plant systematic research in the country since it's the only internationally recognized facility/institution for plant systematic works in the country. The National Herbarium holds representative specimens of all the plant species found in the country, providing opportunities for discovery of plant species new to Bhutan or science. It is also a repository of botanical information and knowledge to guide conservation of prioritized plant species. The National Herbarium has an established herbarium collection and management protocol of international standard, which can be adopted by other herbaria in the country.

Weaknesses

The work of the National Herbarium is mostly limited to explorations and collections since it faces challenges in the accurate determination of species due to limited taxa specific experts and access to recent publications. The study of potential new species or species complex studies is hindered due to limited access to historical collections and type specimens which are deposited in regional or international herbaria and specimens from similar geographic regions. There is limited international collaboration in plant systematic work due to the absence of approved procedures for deposition of duplicate specimens at the regional/ international herbaria. Further, with limited capacity and infrastructure, the National Herbarium is currently confined to only morphological studies of plants.

5.4. Vision

A *centre of excellence in plant systematics.*

5.5. Mission

Expand information and knowledge base on Bhutanese flora.

5.6. Goals

5.6.1. Short-term (2018-2023)

Goal 1: Efficiency of the National Herbarium enhanced.

Strategy 1: *Strengthen collection management standards.*
Action 1.1.1: Improve documentation of botanical information and knowledge.
Action 1.1.2: Strengthen curation of the collections (work on backlog specimens, update classification system, update taxonomy of species, and management of specimens).
Action 1.1.3: Mobilize resources for additional collections and improvement of facilities.
Action 1.1.4: Establish and/ or strengthen collaboration with relevant regional and international organizations.

Strategy 2: *Improve accessibility to collections and data.*
Action 1.2.1: Develop a protocol for national and international herbarium specimen exchange and loaning.
Action 1.2.2: Establish facilities for digitization of herbarium specimens.
Action 1.2.3: Provide access to physical and digital herbarium specimens for research.
Action 1.2.4: Repatriate historical/type specimens, at least in digital form.

Goal 2: Collections and depositions of at least 25 percent of species not represented in the National Herbarium.

Strategy 1: *Initiate gap assessments of plant species and collection locations.*
Action 2.1.1: Conduct gap assessment of the species and collection locations.
Action 2.1.2: Update data on plant distributions and ranges.
Action 2.1.3: Collect specimens of under-collected species.
Action 2.1.4: Collect specimens from locations with least or no collections obtained.

Goal 3: Plant taxonomic research enhanced.

Strategy 1: *Enhance taxonomic studies of prioritized species.*
Action 3.1.1: Enhance capacity to undertake taxonomic research.

Action 3.1.2: Identify and conduct taxonomic studies of prioritized species.
Action 3.1.3: Initiate molecular studies.

5.6.3. Mid-term Goals (2024-2028)

Goal 4: Collections, preservation and management advanced.

Strategy 1: *Strengthen gap assessment and collections.*
Action 4.1.1: Strengthen data on plant distributions and ranges.
Action 4.1.2: Strengthen collection of specimens of under-collected species.
Action 4.1.3: Strengthen collection of specimens from locations with least or no collections obtained.

Strategy 2: *Improve services of the National Herbarium.*
Action 4.2.1: Provide plant identification services.
Action 4.2.2: Promote and share information and knowledge on plants.
Action 4.2.3: Promote national, regional and international collaborations.
Action 4.2.4: Increase the use of herbarium specimens for any floristic research.
Action 4.2.5: Increase deposition of voucher specimens in the National Herbarium.

Goal 5: Plant systematics research strengthened.

***Strategy 1*:** *Strengthen plant systematics research.*
Action 5.1.1: Enhance capacity and facilities to undertake plant systematic research.
Action 5.1.2: Initiate systematics research.

5.6.4. Long-term goals (2029-2033)

Goal 6: Plant systematics and floristic research advanced.

Strategy 1: *Comprehensive gap assessments and collections.*
Action 6.1.1: Enhance data on plant distributions and ranges.
Action 6.1.2: Strengthen and complete collection of specimens of under-collected species.
Action 6.1.3: Strengthen and complete collection of specimens from locations with least or no collections obtained.

Strategy 2: *Advance plant systematics and floristic research.*
Action 6.2.1: Enhance systematics and floristic research.
Action 6.2.2: Conduct botanical collection excursions of prioritized species.

6. Royal Botanical Garden, Serbithang (RBGS)

6.1. Brief background

The Royal Botanical Garden, Serbithang is the only botanical garden in the country and has a total area of about 32 acres. The foundation stone for the establishment of the Royal Botanical Garden, Serbithang was laid on 26th May, 1999 by Her Majesty Ashi Sangay Choden Wangchuck to commemorate the silver jubilee celebration of His Majesty the 4th Druk Gyalpo's golden reign. It was established as an institutional area with living collections of plant diversity found in the country with the following objectives:

a. To act as a conservation (*ex situ)* site for scientific studies.
b. To showcase the nation's floral wealth to visitors.
c. To act as educational resources for school children and other users.
d. To act as a recreational site for public.

The initial establishment was facilitated through the funding support of BTFEC, where basic infrastructure of the garden was developed. Further, in order to implement activities to achieve its objective, BTFEC provided a 2nd phase grant amounting to Nu. 5.515 million from July 2001 to January 2004. Post-2004, the garden was mainly funded through the Royal Government of Bhutan (RGoB), with the exception of the Darwin Initiative project implemented from 2004-2006 to develop capacity of the staff and garden through technical exchange program with Royal Botanic Gardens, Edinburgh.

Between 2012 and 2013, the Royal Botanical garden formulated and implemented a collaborative project titled *"Rescue and restore rare plant species found at Mangdechu Hydro Power Authority (MHPA) project sites"* with MHPA amounting to Nu. 175,000.00. This project documented the existing floral diversity of the MHPA project affected sites and rescued selected species from the project affected sites for *ex situ* conservation at the botanical garden. The collaborative project exemplified the benefits of collaboration between a conservation agency and development partner and subsequently led to the botanical garden receiving funding support to carry out similar activities from Tangsibji Hydro Power Project Authority. Therefore, from January 2014 to June 2017, the botanical garden implemented a project titled *"Rescue and rehabilitation of threatened and rare plant species from 118 MW Nikachhu Hydropower project sites for long-term conservation and development of national repository of botanical information"*. The project with a total fund

of Nu. 3,607,075.00 was collaborative project between National Biodiversity Centre, Ministry of Agriculture and Forests, Serbithang and Tangsibji Hydro Energy Limited.

6.2. Functions

a. Serve as the living repository of plant genetic diversity for *ex situ* conservation and research.
b. Serve as a rescue centre for rare and threatened floral species and promote restoration.
c. Promote propagation of prioritized native plants species to reduce pressures on collection from the wild and to ensure their sustainable use.
d. Provide facilities and services for plant propagation and environmental education.
e. Promote regional and international linkages for effective conservation and management of native plant species.

6.3. Current Status

The garden currently has a little over 800 species of native plants in its collections. Some of the basic infrastructure and amenities developed over the last 18 years include access road, footpath, children's play area and public toilets, greenhouses and nurseries, orchid house and a glass house. The garden is currently managed by four regular full time technical staff with basic taxonomic and horticultural skills, two contract staff and a Curator and supported by 10 Elementary Service Personnel (ESP).

In terms of conservation activities, in addition to living collections management, the garden has also ventured into seed-banking of native trees and shrubs of conservation significance and rescue and restoration of plant species from hydropower projects sites. The wild seed-banking initiative is currently supported by the Garfield Weston Foundation Global Tree Seed Bank Project through Millennium Seed Bank, Royal Botanical Gardens, Kew, with a total fund of Great Britain Pound (GBP) 59,060.00 spread over three years from 2016 to 2019. Preliminary research on selection and propagation of native ornamental plants is also one of the new initiatives of the botanical garden.

Of recent, the botanical garden has also been involved in publishing plant guide books as well as in discovery and description of new species. Recent publication led by the botanical garden include *A Field Guide to Selected Trees, Shrubs and*

Herbs of the Tangsibji Hydro Energy Project Area (2017), A Pictorial guide to the Trees and Shrubs of the Royal Botanical Garden, Serbithang (2017) and *A Century of New Orchid Records in Bhutan (2017)*. A new orchid species *Spathoglottis jetsuniae* N.Gyeltshen, K.Tobgyel & Dalström was also described and named in honor of Her Majesty Gyaltsuen Jetsun Pema Wangchuck in 2017.

Strengths

The botanical garden serves as one of the few places to connect with nature in the rapidly developing capital city of Thimphu due to its close proximity and also because it is one of the few green, public areas in the capital. It is also an outdoor learning place for students in the capital.

Since the garden is located in a beautiful natural landscape, it has great potential to become a very beautiful botanical garden of national pride with little investment in landscape development to improve accessibility and aesthetics. In addition, since Bhutan is endowed with rich floral diversity, the garden has the potential to promote innovative use of this diversity for urban greenery and beautification with focused research on plant selection and propagation.

Weaknesses

Based on the initial objective to "represent the nation's floral wealth" for the past 18 years, the garden has consolidated efforts to collect and grow plants from all climatic zones of the country. However, as the garden is located in the temperate conifer zone, the garden has not been fully successful in growing plants from other climatic zones. It is also economically not viable to create artificial environments to grow plants from sub-tropical and alpine zones. Therefore, the best possible option is to focus on temperate plants since the temperate zone also has a huge diversity of plants of all habits. Other issues which need to be addressed to realize the garden's full potential include the following:

1. Appropriate staff size. (e.g. full time curator, horticulturist, environmental education manager, marketing and public relations personnel, gardeners, etc.).
2. Technical competency of the staff in botanical garden management. (Plant collection and *ex situ* conservation science, data management, propagation/ornamental horticulture, landscaping, environment education,

plant taxonomy, etc.)
3. Appropriate garden and garden amenity infrastructure, including access ways.
4. Proper irrigation and drainage systems.
5. Access to sustained national and international funds and other innovative funding for continuous development and maintenance.
6. Active collaboration with other international gardens for research and development.

6.4 Vision

A national icon connecting people and nature.

6.5 Mission

To become a world class temperate botanical garden with focus on native plant conservation research and plant-centered learning and recreation.

The Botanical garden will strive to achieve its vision and mission through short, medium and long term goals supported by a number of strategies as follows:

6.6. Goals

6.6.1. Short-term (2018 to 2023)

Goal 1: Adopt scientific protocol for living collection management and improve existing infrastructure.

Strategy 1: *Strengthen collection science and ex situ conservation management.*
Action 1.1.1: Develop and implement a collection protocol and a plant database management system.
Action 1.1.2: Strengthen scientific management of the living collections.
Action 1.1.3: Develop capacity of staff in botanical garden collection management, horticultural and management techniques.
Action 1.1.4: Improve and reorganize existing collections into thematic groups.
Action 1.1.5: Gap analysis of diversity and development of collection plans.
Action 1.1.6: Initiate research on living plant management and ornamental horticulture (e.g. propagation and management trials of prioritized species, exploration of native species with potential for ornamental horticulture, wild seed conservation).

Strategy 2: *Improvement of existing infrastructure for amenity and collection management.*
Action 1.2.1: Redevelopment of footpath and access roads to make it wheelchair-friendly.
Action 1.2.2: Redevelopment of irrigation system and lighting.
Action 1.2.3: Development of drainage systems including retention walls.
Action 1.2.4: Redevelopment of signage and amenities (toilets, sitting areas, bridges, children play area, picnic spots, viewpoint, etc.).
Action 1.2.5: Construction of a large-scale propagation house (polycarbonate house with heating facility).
Action 1. 2.6: Improvement of the micro-propagation facility.

Goal 2: Standardized environmental education institutionalized at the botanical garden.

Strategy 1: *Strengthen environmental education program.*
Action 2.1.1: Draft targeted environmental education curriculum for students.
Action 2.1.2: Develop an interpretation centre with a defined role in environmental education.
Action 2.1.3: Develop a forum for interaction between students and RBGS staff based on the curriculum activities.
Action 2.1.4: Develop standardized programs for different categories of visitors (farmers, nature guide trainees, floriculture entrepreneurs, etc.).

6.6.2. Mid-term (2023 to 2028)

Goal 3: More than 50 percent of Thimphu schools visit the botanical garden.

Strategy 1: *Strengthen implementation of environmental education program.*
Action 3.1.1: Review and continue implementation of environmental education program.
Action 3.1.2: Explore innovate measures for engaging students and public. (Eg. intern, volunteers, trainees and farmers' tours (Public).
Action 3.1.3: Develop staff capacities in innovative environmental education programs.
Action 3.1.4: Consult, develop and implement a yearly scheduled outdoor learning program for schools.

Strategy 2: *Diversify collections of public interest and maintain collections and*

garden infrastructures and amenity facilities to the highest standards.
Action 3.2.1: Showcase plants of public interest to inculcate interest and educate visitors on Bhutan's biodiversity (e.g. rare, endemic and threatened plants, native ornamental plants, medicinal plants, relict plants).
Action 3.2.2: Demonstrate best practices of growing and managing plants and thematic gardens.
Action 3.2.3: Regular maintenance of garden facilities.

6.6.3. Long-term goals (2028 to 2033)

Goal 4: 50 percent of native temperate species represented at the botanical garden as living collections.

(Note: Current status: ca. 200 temperate species as living collection, likely total number of temperate species in the country: 1800. 50% of 1800= 900).

Strategy 1: *Expansion of species diversity and thematic gardens.*
Action 4.1.1: Expand collection of temperate species to 900 species, based on gap analysis.
Action 4.1.2: Redevelopment and expansion of other thematic collections/gardens.
Action 4.1.3: Development of a temperate fernery.
Action 4.1.4: Strengthen research on propagation of native plants for *ex situ* conservation as living plants, restoration and other uses.

Strategy 2: *Infrastructure development to support expansion of species diversity.*
Action 4.2.1: Construction of a world class orchidarium.
Action 4.2.2: Construction of a state-of-the-art propagation facility, including micro-propagation laboratory.

Goal 5: Botanical garden able to meet recurring costs.

Strategy 1: *Explore/develop/establish/promote self-sustaining initiatives.*
Action 5.1.1: Mass propagation and sale of selected species.
Action 5.1.2: Provide fee-based technical services.
Action 5.1.3: Organize training, workshops and exhibitions.
Action 5.1.4: Collect entry fee, membership fee and venue fee for events (Wedding, birthday celebration, filming, etc.).
Action 5.1.5: Establish a souvenir shop and cafeteria.