

# Mainstreaming Biodiversity into Agriculture Sector for increasing India's food, nutritional and livelihood security



Centre for Biodiversity Policy and Law  
**National Biodiversity Authority**

2019



# **Mainstreaming Biodiversity into Agriculture Sector for Increasing India's Food, Nutritional and Livelihood Security**

**C. Thomson Jacob, Ajay Parida and  
B. Meenakumari**



Centre for Biodiversity Policy and Law  
**National Biodiversity Authority**

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# List of Abbreviations

ABS	Access and Benefit Sharing	DNA	Deoxyribonucleic Acid
ABI	Agro-biodiversity Index	DPPQS	Directorate of Plant Protection Quarantine and Storage
AnGR	Animal Genetic Resource	EPM	Ecological Pest Management
APEDA	Agricultural and Processed Food Products Export Development Authority	FAO	Food and Agriculture Organisation
BD	Biological Diversity	GHG	Green House Gas
BHS	Biodiversity Heritage Site	GI	Geographical Indications
BMC	Biodiversity Management Committee	GIAHS	Globally Important Agricultural Heritage Systems.
BSI	Botanical Survey of India	GVA	Gross Value Added
CBD	Convention on Biological Diversity	HRD	Human Resource Development
CEBPOL	Centre for Biodiversity Policy and Law	ICAR	Indian Council of Agricultural Research
CGRFA	Commission on Genetic Resources for Food and Agriculture	ICMR	Indian Council of Medical Research
CIB	Central Insecticides Board	IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
CSB	Community Seed Bank	IPM	Integrated Pest Management
CSIR	Council of Scientific and Industrial Research	ITPGRFA	International Treaty on Plant Genetic Resources For Food and Agriculture
CWR	Crop Wild Relative	KVK	Krishi Vigyan Kendra
DADF	Department of Animal Husbandry Dairying and Fisheries	LMT	Lakh Metric Tonne
DAH	Department of Animal Husbandry and Fisheries	M.ha	Million Hectare
DAC&FW	Department of Agriculture Corporation and Farmers' Welfare	MIDH	Mission for Integrated Development of Horticulture

MoA&FW	Ministry of Agriculture and Farmer's Welfare	NPOF	Network Project on Organic Farming
MNREGA	Mahatma Gandhi National Rural Employment Gurantee Act	NMOOP	National Mission on oilseeds and oil palm
MoEFCC	Ministry of Environment, Forest and Climate Change	NSC	National Seed Corporation
MT	Million Tonnes	NTC	Normally Traded as Commodities
MTA	Material Transfer Agreement	PBR	People's Biodiversity Register
NBPGR	National Bureau of Plant Genetic Resource	PGR	Plant Genetic Resource
NBAP	National Biodiversity Action Plan	PKVY	Paramapragat Krishi Vikas Yojana
NBA	National Biodiversity Authority	PPV&FRA	Protection of Plant Varieties and Farmers' Rights Authority
NBAGR	National Bureau of Animal Genetic Resources	SAU	State Agricultural University
NBAIM	National Bureau of Agriculturally Important Microorganism	SBB	State Biodiversity Board
NGC	National Green Corp	SBSTTA	Subsidiary Body on Scientific Technical and Technological Advice
NGO	Non-Governmental Organization	SDG	Sustainable Development Goal
NFSM	National Food Security Mission	SHC	Soil Health Card
NLM	National Livestock Mission	SSC	State Seed Corporation
NMSA	National Mission for Sustainable Agriculture	TK	Traditional Knowledge
NPK	Nitrogen, Phosphorous, Potassium	UGC	University Grants Commission

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# Foreword



Biodiversity mainstreaming is the process of embedding biodiversity considerations and concerns into policies, strategies and practices of key public and private actors that rely on biodiversity, so that biodiversity is conserved, and sustainably used, both locally and globally. The concept of mainstreaming biodiversity was included in Article 6(b) of the Convention on Biological Diversity which calls parties to “integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross sectoral plans, programs and policies”. The Goal A of the Strategic Plan for biodiversity 2011-2020 address the underlying causes of biodiversity loss and means of mainstreaming biodiversity across government and society. India accounts for 7-8 percent of all recorded species, including over 48,000 species of plants and 96,373 species of animals. India is also considered to be a centre of origin of rice, brinjal, citrus, banana and cucumber species. A total number of 811 cultivated plants and 902 of their wild relatives, more than 700 species of fungi and over 100 species of bacteria have been documented. Some of the promising genetic resources of India includes landraces of rice from Tamil Nadu (Konamani), Assam (Agnibora), and Kerala (Pokkali); Bhalia wheat and Banni grass for cow feed from Gujarat; wild mushroom (Gucchi) from Himachal Pradesh and buffalo (Murrah and Jaffarabadi) from Haryana and Gujarat. India also has a vast and rich repository of farm animals such as buffaloes, goat, sheep and chicken. Agrobiodiversity plays a crucial role in achieving food security, eradicating hunger, improving human nutrition and essential functions in the agricultural landscapes. In India, agriculture and allied sectors provides food and nutritional security for nearly 1.3 billion Indians, around 54.6% of population is engaged in agriculture and allied activities and contributes 17.4% to the country’s Gross Value Added for the year 2016-2017.

For increasing and conserving India’s biodiversity wealth, it is important to mainstream biodiversity concerns into the agriculture sector. I hope the suggested recommendations provided in the policy intervention document will help in conserving India’s land races, folk varieties, cultivars, domesticated stocks and breeds of animals for human wellbeing. I congratulate CEBPOL team for bringing out this important document for the benefit of the agricultural farmers.

A handwritten signature in black ink, appearing to read 'M. S. Swaminathan'.

**Dr. M.S. Swaminathan**  
Founder Chairman

MS. Swaminathan Research Foundation Ex-Member of Parliament (Rajya Sabha)



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# Summary

Biodiversity and agriculture are strongly interrelated to each other, the conservation of plant and animal genetic resources plays a crucial role in India's food, nutritional and livelihood security. India is considered to be a centre of origin of rice, brinjal, citrus, banana and cucumber species and it is rich in food crops, oil seed crops, horticultural crops (fruits and vegetables), spices, lichens, algae, fungi, insects and medicinal plants. The increasing replacement of locally adopted and traditionally grown cultivars by high yielding modern varieties has led to the loss of agrobiodiversity resources. Some of the challenges India is facing towards the loss of agrobiodiversity includes: increased use of agro-chemicals, chemical fertilizers, fragmentation, soil degradation, excessive tillage, inappropriate crop rotation, water scarcity, post-harvest losses, natural disasters and climate change impacts. The objective of the present study is to increase the agrobiodiversity by conserving the land races, wild varieties, folk varieties, cultivars, domesticated stocks and breeds. To undertake this policy analysis, various schemes, missions and programmes implemented by the Ministry of Agriculture and Farmers Welfare was reviewed and the tangible recommendations were brought out towards increasing India's agrobiodiversity wealth for the benefit of the human wellbeing. Some of the suggested recommendations for mainstreaming biodiversity into the agricultural sector are to promote ecological agriculture; conservation of agrobiodiversity related plant genetic resources (in the form of seed, vegetative propagule, tissue, cell, pollen, DNA molecules, etc.); conservation of agrobiodiversity hotspots; encourage on-farm conservation practices; preparation of agrobiodiversity index; promote native pollinators; conservation of traditional seed varieties and crop wild relatives; conservation of indigenous livestock breeds; documentation of traditional knowledge associated with sustainable agricultural practices & management; increase capacity building and awareness on agrobiodiversity issues.



# 1 Introduction



India comprises seven climate regions and covers ten biogeographic regions. Of the 34 globally identified biodiversity hotspots, East Himalaya, Indo-Burma and Western Ghats occur in Indian region. These regions are considered as the centre of diversity for many cereals, legumes/pulses, vegetables, fruits, spices, condiments, medicinal plants. Agriculture plays a vital role in India's economy. Agriculture and allied sectors provides food and nutritional security for nearly 1.3 billion Indians, around 54.6% of population is engaged in agriculture and allied activities (Census, 2011) and it contributes 17.4% to the country's Gross Value Added (GVA) for the year 2016-2017<sup>1</sup>. Due to the significance of agriculture in national food security and employment, its performance is central to India's policy and planning.

Agriculture biodiversity or agrobiodiversity encompasses all components of biological diversity relevant to food and agriculture and constitutes the structure and key functions of the agricultural ecosystems. It plays a crucial role in achieving food security, eradicating hunger, improving human nutrition and provides essential functions in the agricultural landscapes. Some of the ecosystem services provided by the agrobiodiversity includes nutrient cycling, decomposition of organic matter, soil formation and rehabilitation, mitigation of climate change, pest and disease regulation and pollination to sustain food production for the human wellbeing<sup>2</sup>. Biodiversity is critical to sustain resilience and adaptability of agricultural production systems. The availability of food and nutrition basket has expanded globally due to exchange and effective use of agrobiodiversity. Of the nearly 250,000 globally identified plant species, about 7,000 have historically been used in human diets. At present, however, only about 30 crops form the basis of world's agriculture and just three species of maize, rice and

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1. Annual Report 2017-18. Published by the Department of Agriculture, Cooperation & Farmers Welfare Ministry of Agriculture & Farmers Welfare, (MoA&FW), Government of India (GoI).
  2. Cancun Declaration, 2016. CoP-13 United Nations Biodiversity Conference - Cancun Declaration on Mainstreaming the Conservation and Sustainable Use of Biodiversity for Well-being, held at Cancun, Mexico.



wheat supply more than half of the world's daily calories<sup>3</sup>. Hence, it is important to conserve the variability of animals, plant and microorganisms at genetic, species and ecosystem levels to sustain key functions of the agroecosystem.

Agriculture, intended in the broad sense as productive systems of crop, livestock, forestry, fisheries and aquaculture. The food production must increase by almost 50 percent globally to provide sufficient, good quality food for almost 11 billion people. Presently in most affected regions the natural resource base of soils, water, land, and ecosystems upon which food production depends is under stress, degraded, or significantly depleted<sup>4</sup>.

## 1.1 India's agrobiodiversity wealth

Agrobiodiversity includes all components of biological diversity, relevant to food and agriculture. It encompasses varieties, breeds and populations of useful plants, animals, and fish species along with the diversity of insects, microbes and other species which are part of the production systems<sup>5</sup>. Agrobiodiversity is the basis for the development of food products. With only 2.4 percent of the world's land area, India accounts for 7-8 percent of all recorded species, including 47,513 species<sup>6</sup> of plants and 96,373 species of animals<sup>7</sup>. India is also considered to be a centre of origin of rice, brinjal, citrus, banana and cucumber species. A total number of 811 cultivated plants and 902 of their wild relatives, more than 700 species of fungi and over 100 species of bacteria have been documented. Some of the promising genetic resources of India includes landraces of rice from Tamil Nadu (Konamani), Assam (Agni bora) and Kerala (Pokkali); Bhalia wheat and Banni grass for cow feed from Gujarat; mushroom (Guchhi) from Himachal Pradesh and buffalo (Murrah and Jafarabadi) from Haryana and Gujarat<sup>8</sup>.

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3. Biodiversity and Agriculture-Safeguarding Biodiversity and securing food for the world. Published by the Secretariat of the Convention on Biological diversity (CBD), Quebec, Canada. ISBN: 92-9225-111-2.

4. FAO, 2017. Landscapes for Life approaches to landscape management for sustainable food and agriculture, Published by Food and Agriculture Organization (FAO) of the United Nations Rome, 2017.

5. Paroda R.S., R.K. Tyagi, P.N. Mathur, Anuradha Agrawal, Sunil Archak, R.C. Agrawal and Sonal Dsouza (Editors) (2017). Proceedings of the '1st International Agrobiodiversity Congress: Science, Technology and Partnership', New Delhi, India, November 6-9, 2016. Indian Society of Plant Genetic Resources, New Delhi and Bioversity International, Rome, 152 p.

6. Singh, P. and Dash, S.S, 2014. Plant Discoveries 2013. New Genera, Species and New records. Published by the Botanical Survey of India, Kolkata.

7. India's Fifth National report to the CBD, 2014. Published by Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India (Gol).

8. Paroda R.S., R.K. Tyagi, P.N. Mathur, Anuradha Agrawal, Sunil Archak, R.C. Agrawal and Sonal Dsouza (Editors) (2017). Proceedings of the '1st International Agrobiodiversity Congress: Science, Technology and Partnership', New Delhi, India, November 6-9, 2016. Indian Society of Plant Genetic Resources, New Delhi and Bioversity International, Rome, 152 p.



India also has a vast and rich repository of farm animals, represented by a broad spectrum of native breeds of cattle (42), buffaloes (15), goat (34), sheep (43) and chicken (19)<sup>9</sup>. Insects forms nearly 75 percent of all animals, representing tremendous diversity<sup>10</sup>. The growth of the dairy sector has been a major success for India with an estimated production of 165.4 million tonnes in 2016-17. India continues to be the largest producer of milk in the world. The per capita availability of milk has reached 355 grams per day during 2016-17, which is more than the world average of 294 grams per day. In the production of meat, egg and wool, a significant progress have been witnessed<sup>11</sup>.

## 1.2 Bioeconomy and agriculture

India is rich in food crops, oil seed crops, horticultural crops (fruits and vegetables), lichens, algae, fungi, insects and medicinal plants, which provide bioresources for producing various economically important bioproducts. India is having around 15,658 rice landraces and the largest exporter of Basmati rice and produces several indigenous and local varieties of wheat, pulses, and millets that have high nutritional value. India is also the largest producer of spices, which includes ginger, turmeric, cardamom, clove, cinnamon, black pepper, mace, mustard, nutmeg, fennel, asafoetida, etc. These spices are used for flavouring, colouring, preserving, food preparations and medicinal applications<sup>12</sup>. India's fast growing bioeconomy has crossed \$35.1 billion in 2015 and India has set an ambitious target of achieving a bioeconomy of \$ 100 billion by 2025<sup>13</sup>.

## 1.3 Agriculture practices and status in India

The total geographical area of the country is 328.7 million hectares (m.ha) of which 140.1

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9. India's 5th National report, 2014 to the CBD, Published by the MoEF&CC, Gol and National Bureau of Animal Genetic Resources web resources (<http://nbagr.res.in/>).

10. Indian Council of Agricultural Research (ICAR) -National Bureau of Agricultural Insect Resources (<http://www.nbair.res.in/>).

11. Animal Husbandry and Fisheries Statistics, 2014, Published by the Fisheries Survey of India. Department of Animal Husbandry, Dairying and Fisheries, MoA&FW, Gol.

12. National Mission on Bio-economy sustainable development through a green economy, 2016 (Draft), Published by the Institute of Bioresources and Sustainable Development, Shillong, Meghalaya.

13. *ibid*



m.ha is reported net sown area and 198.4 m.ha is the gross cropped area<sup>14</sup>. The net area sown works out to be 43 percent of the total geographical area. The net irrigated area is 68.4 m.ha. Rainfed agriculture plays a crucial role in the India's economy. It covers about 54 percent of the country's net sown area and accounts for 40 percent of total food production. The National Rainfed Area Authority of India has estimated that 77 percent of pulses, 66 percent of oilseeds and 45 percent of cereals are grown under rainfed conditions. It also supports two-third of the livestock population and simultaneously plays a vital role in providing India's food security<sup>15</sup>. Increasing productivity of rainfed cropping systems are of critical importance to meet the food demands of the increasing population in India and also the wild agriculture biodiversity available in these landscape plays a significant role.

## **1.4 Aichi targets, National targets and SDGs related to agriculture sector**

India is one of the first country which has enacting the Biological Diversity (BD) Act, 2002. As per the guidance of the Convention on Biological Diversity (CBD), India had revised its National Biodiversity Action Plan (NBAP) by developing 12 national biodiversity targets and 175 action points<sup>16</sup>, keeping in view of the global Strategic Plan for Biodiversity 2011-2020 (including the Aichi Biodiversity targets) adopted during 2010. These global targets are developed towards (a) halting biodiversity loss by mainstreaming biodiversity across government and society; (b) reducing the direct pressures on biodiversity and promote sustainable use; (c) improving status of biodiversity by safeguarding ecosystems, species and genetic diversity; (d) increasing benefits to all from biodiversity and ecosystem services; and (e) enhancing implementation through participatory planning, knowledge management and capacity building. The sustainable agrobiodiversity management require the functional convergence of global and national policies and regulatory framework.

The food production and agriculture are having a significant implications for all of the Aichi biodiversity targets and in particular the target 3 (incentives reforms), target 4 (sustainable

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14. Annual Report 2017-18. Published by the Department of Agriculture, Cooperation & Farmers Welfare, MoA&FW, Gol.

15. State of Environment Report, 2015 (Draft). Published by the MoEFCC, Gol.

16. National Biodiversity Action Plan (NBAP) Addendum 2014 to NBAP 2008. Published by the MoEFCC, Gol.



consumption and production), target 7 (sustainable agriculture), target 9 (invasive alien species prevented and controlled), target 13 (genetic diversity maintained) and target 16 (Nagoya Protocol in force and operational). Some of India's national targets that address agricultural issues are target 5 (sustainable management of agriculture) and target 7 (genetic diversity maintained and minimizing the genetic erosion). Some of the Sustainable Development Goals (SDGs) relevant to the conservation and sustainable use of agrobiodiversity includes<sup>17</sup>:

**Target 5 - By 2020, measures are adopted for sustainable management of agriculture, forestry and fisheries;**

**Target 7 - By 2020, genetic diversity of cultivated plants, farm livestock and their wild relatives, including other socio-economically as well as culturally valuable species, is maintained and strategies have been developed and implemented for minimising genetic erosion and safeguarding their genetic diversity.**

The SDG 2 emphasises that by 2030, the agricultural productivity and the income of the small-scale food producer's (women, indigenous people, family farmers, pastoralists and fishers) doubled and also the genetic diversity of seeds, cultivated plants, farmed & domesticated animals and their wild species need to be maintained.

**SDG 2 : End hunger, achieve food security and improved nutrition and promote sustainable agriculture.**

**SDG 12 : Ensure sustainable consumption and production patterns;**

**SDG 15 : Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification and halt and reverse land degradation and halt biodiversity loss.**

17. Linking Sustainable Development Goals to National Biodiversity Targets, Published by Biodiversity Finance Initiative, United Nations Development Programme (UNDP), 2016, India.



## 1.5 Women and Biodiversity

The CBD recognises the vital role of women in conservation and sustainable utilization of biodiversity and affirms the need for the full participation of women at all levels of policy making and implementation of biodiversity conservation. In India, there are about 53 million tribal people belonging to 550 communities involved in conserving the agrobiodiversity resources. Two-thirds of the tribal population live in central India, in the states of Madhya Pradesh, Orissa, Bihar, Gujarat and Rajasthan and 80 percentage of the population living in the North-Eastern states of Meghalaya, Nagaland, Mizoram and Arunachal Pradesh are involved in the conservation of agrobiodiversity.

In India, men and women have different kinds of knowledge and information, women are mainly responsible for seed selection and storage, exchanging seed and ensuring that local agrobiodiversity is preserved. Ecological knowledge and skills in a tribe like the Apatani tribes are clearly gender-based. Older women identify varieties of paddy suited in different soil conditions and also select pure seed. In the North Eastern region, there are immense genetic resources of coir, jute, saccharum, cucurbits, rice, niger, sesame and forage grasses. In the Western Himalayan tribal belt, there are considerable genetic variability in buck wheat, amaranth, soybean, lentil, cowpea, pome and fruits. In these tribal villages women plays a crucial role in conserving the traditional ranges of food crops and medicinal plants. The study carried out by the M.S. Swaminathan Foundation says that in India, women play an important role in conserving the agrobiodiversity resources in places like Wayanad, Kolli hills, Jeypore tract, Bhitarkanika and Lakshadweep island<sup>18</sup>.

## 1.6 Global and National Governance

The CBD provides a global framework for conservation and sustainable use of biodiversity. Food and Agriculture Organisation (FAO) commission on Genetic Resources for Food and Agriculture (CGRFA) is an intergovernmental permanent forum for governments to discuss and negotiate matters specifically relevant to agricultural biodiversity. It also monitors the status

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18. Sharing Innovative Experiences 5, Agriculture and Rural Development in the South. Published by MS Swaminathan Research Foundation, Chennai.



of genetic resources for food and agriculture and takes appropriate action through global action plans, codes of conduct and guidelines. The objectives of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) are conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of benefits arising out of their use, in harmony with the CBD, for sustainable agriculture and food security. The Nagoya Protocol is a legally binding framework adopted in Nagoya, Japan to promote a transparent and effective implementation of the Access and Benefit Sharing (ABS) concept at the regional, national and local level.

Some of the national frameworks in India dealing with agriculture and the food sector includes National Agricultural Policy, 2000; National Policy for Farmers, 2007; National Seed Policy, 2002; National Policy on Agroforestry, 2014; National Policy on Biofuels, 2009; Insecticides Act, 1968; Live-stock Importation (Amendment) Act, 2001; Food Safety and Standards Act, 2006; Protection of Plant Varieties and Farmers' Rights Act (PPV&FRA), 2001 and Biological Diversity (BD) Act, 2002.

## 2 Concerns in the Agricultural Sector



In India, the agricultural science is focusing on increasing the agricultural production through the development of new varieties, breeds, technologies and practices. The quest for increased production and productivity has resulted in overexploitation of natural resources and nearly 37 percentage of the geographical area of the country is affected by different kinds of land degradation. The annual report of the Ministry of Agriculture and Farmer's Welfare (MoA&FW) 2017-18 states that there is a steady decline in the share of agriculture and allied sector in the GVA from 18.6 percent in 2013-14 to 17.4 percent in 2016-17<sup>19</sup>. Some of the concerns related to the agricultural sector are elaborated below:

### 2.1 Increased usage of agricultural chemicals and fertilizers

A wide range of agricultural chemicals are being used to enhance the agricultural yield. These include fertilizers and crop protection chemicals like insecticides, pesticides, fungicides and herbicides. The excessive usage of fertilizers which erode the land quality, pollutes ground and surface water bodies. There is an increase in the utilization of the chemical fertilizers over the period of time, the production of fertilizers during 2014-15 was 370.03 Lakh Metric Tonnes (LMT). The subsidy on Phosphorous, & Potash (P&K) fertilizers have increased from 19389.64 crores (2005-06) to 77268.56 crores (2014-15)<sup>20</sup>. The use of Nitrogen, Phosphorous and Potassium (N, P2O5, K 2O) have increased from 1.1 million tonnes in 1966-67 to more than 25 million tonnes in 2014-15<sup>21</sup>. India ranks second in total world fertilizer consumption in 2012 and the average consumption of fertilizer increased from 69.84 kg per hectare in 1991-92 to 128.08 kg per hectare in 2014-15.

19. Annual Report 2017-18. Published by the Department of Agriculture, Cooperation & Farmers Welfare, MoA&FW, Gol.

20. Annual report 2015-16. Department of Chemicals and Petrochemicals, Ministry of Chemicals and Fertilizers Department of Chemicals and Petrochemicals, Government of India.

21. Ministry of statistics and programme implementation, Gol (web resource:<http://www.mospi.nic.in>).



## 2.2 Fragmentation of agricultural lands

About 85 percentage of the operational holdings in the country are small and marginal, i.e. that are holding less than 2 hectares each. Increasing fragmentation of land holding is a continuous cause for concern. The number of land holdings increased from 75.41 million to 92.83 million during 2001 to 2011. It is estimated that the average size of land holding, which at present is 1.15 hectare, is likely to reduce further by 2020. The productivity of smallholder agriculture and its contribution to the economy, food security and poverty reduction depends on the services provided by well-functioning ecosystem. This includes major aspects of soil fertility, fresh water delivery, pollination and pest control. These small landholders put stress on ecosystems, for example through modification of landscape, over extraction of water and nutrients and use of pesticides and this has increases the stress on ecosystem functioning<sup>22</sup>.

## 2.3 Soil Degradation

Cropping system with high agriculture biodiversity displayed increased soil carbon and nitrogen compared with low agricultural biodiversity. Out of the total India's geographical area of 328.7 m.ha, about 120.4 m.ha are affected by various kinds of land degradation. This includes water and wind erosion (94.9 m.ha), water logging (0.9 m.ha), soil alkalinity/sodicity (3.7 m.ha), soil acidity (17.9 m.ha), soil salinity (2.7 m.ha) and mining & industrial waste (0.3 m.ha)<sup>23</sup>. The quality of soil has deteriorated over time due to a combination of various factors, such as injudicious use of fertilizer and accumulation of heavy metals and metalloids through various forms of emissions.

## 2.4 Excessive tillage and inappropriate crop rotation

Excessive tillage coupled with heavy machinery reduces organic matters, microbes, earth worm, ants and reduces the number of fungal hyphae. inappropriate crop rotation coupled with lack of proper soil and water conservation measures are seen as significant drivers of

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22. Fourth Semi-Annual Medium Term Agricultural Outlook Report, September, 2015, National Council of Applied Economic Research. Under the Project Sponsored by the National Food Security Mission Ministry of Agriculture Department of Agriculture, cooperation. MoA&FW, Gol.

23. Annual Report 2014-15. Published by the Department of Agriculture, Cooperation & Farmers Welfare, MoA&FW, Gol.



soil erosion. The rotation of crops provides varied diet to soil microorganisms and promotes a diverse soil flora and fauna<sup>24</sup>.

## 2.5 Loss of agrobiodiversity

The important concerns for the loss of agrobiodiversity are land use change, habitat loss, degradation and fragmentation, spread of Invasive Alien Species, pollution (pesticides, insecticides, fertilizers and other agro-chemicals), simplification of cropping systems, climate change, water scarcity, deterioration of soil health, population pressure, burning of crop residues, erratic rainfall, declining ground water, natural disasters and drought. The loss of agricultural biodiversity leads to the decline in many ecosystem services threatening to undermine the productivity and sustainability of agriculture, reduced distribution and abundance of populations of species, loss of genetic diversity and the loss of unique habitats. The increasing demands for food combined with socio-economic development efforts threatens the existence of traditional varieties and lead to the destruction of natural habitats of wild species. This has resulted in narrowing of genetic base – ‘genetic erosion’ and ‘genetic wipe-out’<sup>25</sup>.

## 2.6 Climate Change

Climate change has become a serious global negative externality with its multiple, far-reaching and persistent effects. India’s large size, its numerous agroecological zones, preponderance of small, fragmented holdings and persistent dependence on the vagaries of the monsoon, the issue of climate change becomes challenging. Estimates suggest that about 18 percent of the annual Green House Gas (GHG) emissions in India during 2007 were from the agricultural sector. The major sources of these emissions are from enteric fermentation (63.4 %), rice cultivation (20.9 %), agricultural soils (13.0%), manure management (2.4%) and on-field burning of crop residues (2.0%)<sup>26</sup>.

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24. Fiona Marshall, Mike Ashmore & Fiona Hinchcliffe, 1995. A hidden threat to food production: Air pollution and agriculture in the developing world, Gate Keeper Series No. SA73-2. Published by the International Institute for Environment and Development under the Sustainable Agriculture and Rural Livelihoods Programme.

25. Agrobiodiversity – Plant genetic resources, Published by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), GmbH prepared under the Sector Project Sustainable Agriculture (NAREN), [www.giz.de/sustainable-agriculture](http://www.giz.de/sustainable-agriculture).

26. State of Environment Report, 2015 (Draft). Published by the MoEFCC, Govt. of India.

### 3 Approaches and best practices for mainstreaming biodiversity



Biodiversity mainstreaming is the process of embedding biodiversity consideration into policies, strategies, plan and practices of key public and private actors that impact or rely on biodiversity. The concept of mainstreaming is advocated in Article 6(b) of the CBD<sup>27</sup> and it is also integrated into the Section 36 of the India's BD Act, 2002. The Article 10(a) of the CBD stipulates that each party shall as far as possible and as appropriate integrate conservation and sustainable use of biological resources into the national decision making.

The Subsidiary body on Scientific, Technical and Technological Advice (SBSTTA) in its paper on biodiversity, food systems and agriculture has suggested few approaches for mainstreaming biodiversity into the agricultural sector, which includes: (a) Ecological intensification of production; (b) Maintenance of biodiversity in the production landscapes; (c) Sustainable consumption, reduced food waste and sustainable diets<sup>28</sup>. These are the three mutually reinforcing domains of outcomes that are critical for reshaping food system and agriculture towards greater productivity and sustainability. The FAO has provided necessary guidelines for the implementation of Aichi Biodiversity Target 7 for food systems and agriculture and specified necessary tools for mainstreaming biodiversity into the agricultural sector<sup>29</sup>. Some of the suggested best practices are: promoting native biodiversity, increasing the production and consumption of unrefined (raw or minimally processed) nutrient-rich foods (fruits, vegetables, beans, nuts and seeds), nutrition-sensitive landscape approaches (building diversity into landscapes and food systems to improve food diversity at the production level), control of

27. Convention on Biological Diversity: text and annexes. Adopted on 22nd May, 1992. Published by the Secretariat of the CBD, Canada, 2011.

28. Strategic Scientific and Technical issues related to the implementation of the Strategic Plan for Biodiversity 2011-2020. Biodiversity, Food system and agriculture, 2015. UNEP/CBD/SBSTTA/19/INF/1.

29. FAO and biodiversity for food and agriculture (Web Source: <http://www.cbdint/financial/idb2015/fao-foodagro.docx>).



phosphorous pollution; incentive measures (providing positive subsidies, abolishment of distorting subsidies), maintain genetic diversity of resources for food and agriculture and their landraces and wild relatives, promote voluntary/organic certification schemes for sustainably produced goods and services, promote pollinators and improve soil biodiversity, documentation of traditional knowledge practiced by the indigenous/local communities, reduction of post-harvest loss, encouraging traditional farming practices and eradication or control of invasive alien species<sup>30</sup>.

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30. *ibid*

## 4 Objective



The objective of the present study is to increase the agrobiodiversity by conserving the land races, folk varieties, cultivars, domesticated stocks and breeds of animals and agriculturally important organisms available in our country. The focus is also to meet the CBD's objectives viz (a) conservation; (b) sustainable use; (c) fair and equitable sharing of the benefits arising out of the use of biological resources and recognizes the linkages between agricultural production and biological diversity conservation.

## 5 Discussion and recommendations



To integrate biodiversity concerns into agriculture sector, the biodiversity relevant missions, schemes, programmes implemented by the MoA&FW was reviewed and analysed in order to bring out some tangible recommendations. Some of the missions reviewed are: (a) National food security mission (NFSM)<sup>31</sup>; (b) National mission on oilseeds and oil palm (NMOOP)<sup>32</sup>; (c) Mission for integrated development of horticulture (MIDH)<sup>33</sup>; (d) National mission for Sustainable agriculture (NMSA)<sup>34</sup>; (e) National Livestock Mission (NLM)<sup>35</sup>. The emerged recommendations were deliberated during the one-day policy dialogue on mainstreaming biodiversity into agricultural sector, held on 20<sup>th</sup> January, 2017 at Pusa, New Delhi and the recommendations were consolidated in the present document.

### 5.1 Promote ecological agriculture

Biodiversity is the basis of agriculture and its maintenance is essential for the production of food and agricultural goods. The practice of ecological agriculture involves building strengths of natural ecosystems into agroecosystems, which includes: grow healthy plants with good defence capabilities; stressing pests, enhancing populations of beneficial organisms<sup>36</sup>. The overall objective of promoting ecological agriculture is to produce optimal crop yield and quality

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31. National Food Security Mission, Operational guidelines, 12th Five year Plan. Published by the Department of Agriculture & Cooperation, MoA&FW, Gol.

32. National Mission on Oilseeds and Oil palm, Operational guidelines. Published by the Department of Agriculture & Cooperation, MoA&FW, Gol.

33. Mission for Integrated Development of Horticulture, Operational guidelines, 2014. Published by the Horticulture Division, Department of Agriculture & Cooperation, MoA&FW, Gol.

34. National Mission for Sustainable Agriculture, Operational guidelines, 2014. Published by the Department of Agriculture & Cooperation, MoA&FW, Gol.

35. National Livestock Mission, Operational guidelines, Published by the Department of Animal Husbandry & Fisheries, Krishi Bhavan, Gol.

36. Fred Magdoff, 2007. Ecological Agriculture: Principles, practices and constraints, Published in Renewable Agriculture and Food Systems: 22 (2) 109 -117, Cambridge University Press.



with high positive and low negative environmental effects. The ecological agriculture farming helps farmers to make use of nature's goods and services in an economically, environmentally and socially rewarding way and it helps us in conserving the agrobiodiversity. Some of the agricultural practices which promote ecological agriculture farming systems includes: organic agriculture, ecological pest management, use of organic pesticide and insecticides, crop rotation, recycling crop and animal waste, mixed farming, multi-cropping, etc.

## A. Organic farming

In India, the consumption of chemical fertilizers in terms of Nitrogen (N), Phosphorous (P), Potassium (K) has increased substantially. The states such as Punjab, Haryana and Andhra Pradesh consumes over 200 kg/per hectare and other states, like Odisha, Kerala, Madhya Pradesh, Jharkhand, Chhattisgarh and Rajasthan consumes less than 100 kg per hectare. Globally, there is an increase in use of organic farming practices and around 37.2 million hectares of agricultural land from 162 countries are under organic agriculture practices<sup>37</sup>. The organic agriculture practices increases species richness by an average of 30%<sup>38</sup> and also it increases the abundance of biomass of all soil organisms, with exception of predaceous nematodes when compared to conventional systems<sup>39</sup>. A scientific study has revealed that, there is a yield reduction of 20% while undertaking organic agriculture, but that yields were more profitable and delivered greater ecosystem services and social benefits<sup>40</sup>.

The MoA&FW is promoting organic farming and trying to minimise the usage of chemical fertilizers through various schemes/ programmes such as NMSA, MIDH, NMOOP and Network Project on Organic Farming (NPRF). In addition to this, the Government is implementing a cluster based programme to encourage farmer for promoting organic farming called Paramparagat Krishi Vikas Yojana (PKVY). The certified cultivated area under organic farming has grown from 4.55 lakh ha. in 2009-10 to 7.23 lakh ha. in 2013-14, with around 6 lakh farmers practising it.

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37. Lee, K.S. et al, 2015. Measuring the Environmental Effects of organic farming: A meta-analysis of structural variables in empirical research, *Journal of Environmental Management*, 162, 263-274.

38. Tuck, S.L., et al, 2014. Land-use intensity and the effects of organic farming on biodiversity: a hierarchical meta-analysis. *Journal of Applied Ecology*, 51, 746-755.

39. Henneron, L., et al, 2015. Fourteen years of evidence for positive effects of conservation agriculture and organic farming on soil life. *Agronomy for Sustainable Development*, 35(1), 169-181.

40. Reganold, J.P., and Wachter, J.M, 2016. Organic Agriculture in twenty-first century. *Nature Plants* 2-1522.



But, still the total area under organic farming is insignificant compared to the net sown area of 140 million hectares. In terms of exports (exports of organic food at about 1.6 lakh tonnes) an estimated value of USD 220 million is less than 1 percent of global exports<sup>41</sup>. Sikkim is the first State of India officially announced the adoption of organic farming in the year 2003 and converted the entire 74,303.84 hectares of agricultural land area as organic<sup>42</sup>.

## **B. Ecological Pest Management**

Pest control is another key ecosystem services provided by biodiversity. Improved pest control depends on diversity of natural enemies of pests and the presence of non-crop habitats for the survival of biological control agents such as predators, parasitoids. Ecological Pest Management (EPM) is an approach to use naturally available biological resources such as bacillus, neem, trichoderma, pseudomonas, etc., thereby, it encourages natural pest control mechanisms<sup>43</sup>. Some of the advantage of using EPM are, it improves soil and water quality, reduces the risk of pesticide poisoning, increases ecological sustainability by conserving natural enemy species, increases agrobiodiversity and reduces genetic erosion. A study published in the National Academy of Sciences says that replacing 10% of crop land with strips of native plant species increases insect taxa richness, greater pollinator abundance and greater native bird species richness<sup>44</sup>.

## **C. Conservation of pollinators**

Pollination is the introductory process leading to the production of offspring in flowering plants<sup>45</sup> and pollinators are essential for the production of a fibre crops, cereals, orchards, horticultural and forage crops. Pollination is one of the most important mechanisms in maintenance and promotion of biodiversity. The diverse groups of the animal kingdom,

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41. State of Indian Agriculture 2015-2016. Published by the Cooperation & Farmers Welfare Directorate of Economics and Statistics, MoA&FW, GoI, New Delhi.

42. Sikkim Organic Mission, Web resource, published by the Government of Sikkim ([www.sikkimorganicmission.gov.in](http://www.sikkimorganicmission.gov.in)).

43. Clements, R., J. Hagger, A. Quezada, and J. Torres, 2011. Technologies for Climate Change Adaptation-Agriculture Sector. X. Zhu (Ed.). UNEP Risø Centre, Roskilde, 2011, available at <http://tech-action.org/>- Agriculture Sector. X. Zhu (Ed.). UNEP Risø Centre, Roskilde, 2011, available at <http://tech-action.org>.

44. Schulte, L. et al, 2017. Prairie strips improve biodiversity and delivery of multiple ecosystem services from corn-soybean croplands. Proceedings of the National Academy of Sciences. 10.1073/pnas.1620229114.

45. Orjan Totland, 2013. Norwegian University of Life Sciences. The state of knowledge about insect pollination in Norway - The importance of the complex interaction between plant and insects. Published by Norwegian Biodiversity Information Centre.



pollinates include bees, birds, bats, opossums, giraffes, reptiles, flies, beetles, moths, butterflies and wasps. It was reported that nearly 90% of the world's wild flowering plant species depend, entirely or at least in part, on animal pollination. These plants are essential for the functioning of ecosystems through the provision of food, habitat and other resources to other species. More than three quarters of the leading food crops benefit to some extent from animal pollination, with an estimated annual market value of US\$ 235 - 577 billion in 2015. In addition to that, even auto-pollinated crops like soybean can benefit from enhanced productivity by animal pollinators<sup>46</sup>.

The Intergovernmental Science-Policy platform on Biodiversity and Ecosystem Services (IPBES) study<sup>47</sup> says that nearly 5 to 8 percentage of global crop production depends on animal pollination and the diversity of pollinator's decreases due to intensive agricultural practices. As two-thirds of the world's major food crops are pollinator- dependent. Conversely the increase in wild insect pollinator richness and abundance was found to result in high and more consistent crop yields. For achieving a 50% pollination threshold in a single site requires an average of 5.5 bee species and for larger region it requires 55 species<sup>48</sup>. The decline in pollinator species will negatively affect the agriculture productivity and sustainability. Destruction of habitats and extinction of specific species of plants threaten pollinator diversity, similarly, extinction of pollinator species threatens the plants species. The biodiversity of pollinators and plants are thus strongly linked.

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46. Milfont, M., Rocha, E.E.M., Lima, A.O.N. and Freitas, B. M., 2013. Higher soybean production using honeybee and wild pollinators, a sustainable alternative to pesticides and auto pollination *Environ. Chem. Lett.* 11:335.

47. IPBES, 2016. The assessment report of the Intergovernmental Science-policy Platform on Biodiversity ad Ecosystem services on pollinators, pollination and food production. S.G. Potts, V. L. Imperatriz-Fonseca, and H.T. Ngo (eds), Secretariat of the IPBES, Bonn, Germany, 552 pages.

48. Winfree, R. et al, 2018. Species turnover promotes the importance of bee diversity for crop pollination at regional scales *Science* 359, 791-793.



## Action Points

- A comprehensive well defined policy on “Ecological Agriculture” for sustaining India’s Agrobiodiversity need to be developed by combining all the relevant existing schemes and programmes of the Agricultural Ministry.  
{Note: Ecological agriculture includes organic farming, ecological pest management, promoting native pollinators, multi-cropping, crop rotation, certification of organic products, reducing post-harvest losses, etc.}.
- While under taking the Soil Health Card (SHC) analysis, it is suggested to include the biodiversity assessment in the organic cultivation practiced areas (some of the biodiversity parameters can be analysed includes: algae, fungi, nematodes, small annelids, millipedes, centipedes, earth worm, etc.).
- Native food based strategies need to be developed for promoting traditional varieties of rice, wheat, pulses, cereals and to generate food composition data of nutritional importance. The highly nutritious local/native varieties can be distributed through the Public Distribution System.
- Incentives need to be provided for (a) cultivating native indigenous land race varieties; (b) producing bio-fertilizers, micronutrients (e.g., production of bio NPK, BioPhos, BioPhos+, BioZinc, BioPotash); (c) producing organic pesticides; (d) adopting micro-organism technologies; (e) promoting pollinator species in the agricultural landscape, etc.
- To increase the pollinators in the agricultural landscape, an insect hotel can be provided by planting native trees, herbs, climbers, flowering plants in the fences of the agricultural field. Necessary ecological infrastructures such as hedges, small ponds and beetle banks can also be created to provide habitats for native pollinators.
- Along with honey-bees, other native agriculturally important insects can be promoted viz moths, wasps, beetles, etc. under the MIDH. Also the native bees such as *Amegilla zonata*, *Hoplonomia westwoodi*, *Amegilla zonata* and *Hoplonomia westwoodi* can be promoted.

## 5.2 Conservation of Agrobiodiversity

### 5.2.1 Conservation of on-farm practices and agrobiodiversity hotspots

On-farm conservation involves the maintenance of traditional crop cultivars or landraces and farming systems by farmers within traditional agricultural systems. On- farm or *in-situ* conservation maintains plants and crops in their natural habitats where traditional farming is prevalent and crops that are often enriched by gene exchange with wild relatives<sup>49</sup>. It is important to protect the on-farm conserved areas towards conserving agrobiodiversity.

49. K. Subramanian, Subhashini Sridhar, Shylaja Narayanan, A.V. Balasubramanian and K. Vijayalakshmi, 2013. On-farm Conservation of Indigenous Seeds. Published by the Centre for Indian Knowledge Systems, Chennai Revitalising Rainfed Agriculture Network.



## 5.2.2 Globally important Agricultural Heritage systems

FAO has defined Globally Important Agricultural Heritage Systems (GIAHS) as “remarkable land use systems and landscapes which are rich in globally significant biological diversity”. The main objectives of GIAHS are to leverage global and national recognition of the importance of agricultural heritage systems and institutional support for their safeguard; capacity building of local farming communities and local and national institutions to conserve and manage GIAHS; generate income and add economic value to goods and services of such systems in a sustainable fashion; to promote enabling regulatory policies and incentive environments to support the conservation, evolutionary adaptation and viability of GIAHS<sup>50</sup>.

GIAHS sites focus agricultural production as a basis and has both tangible and intangible effects (e.g., endemic, domesticated, rare, endangered species of crops and animals); local and traditional knowledge systems; cultures, value systems and social organisations and landscapes and seascapes feature). Globally, 37 sites have been designated as GIAHS, out of these three sites are from India, which includes: Saffron (Heritage of Kashmir), Koraput (Traditional Agriculture) and Kuttanad (below sea level farming).

## 5.2.3 Biodiversity hotspots

The Section 37 of the BD Act, specifies that the State Governments may in consultation with the local bodies, can notify areas of biodiversity importance as Biodiversity Heritage Site (BHS). Hence, the important agrobiodiversity areas/hotspots can be designated as BHS under the provisions of the BD Act. The biodiversity hotspots can be defined as richness of biodiversity e.g., number of crop species, varieties, wild relatives, social relevance and ancientness, number of species domesticated and uniqueness of agroecosystems. These are well designed areas with unique, ecologically fragile ecosystems, presence of high endemism, rare and threatened species, keystone species and species of evolutionary significance, wild relatives/ancestors of domestic/ cultivated species or their varieties. These areas are also represented by fossil bed and having significant cultural, ethical or aesthetic values and are important for maintenance for cultural diversity<sup>51</sup>.

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50. FAO, 2017. Landscapes for Life approaches to landscape management for sustainable food and agriculture, Published by Food and Agriculture Organization (FAO) of the United Nations Rome, 2017.

51. Dr. Ravishankar Thupalli, Dr. K. Jahir Hussain, Dr. C. Thomson Jacob, 2013. Biodiversity Management Committees Operational tool kit, Published under the UNEP-GEF ABS Project, NBA



## Action Points

- The globally significant agrobiodiversity rich areas in India can be identified and designated as GIAHS.
- Agrobiodiversity hotspots can be protected and Agrobiodiversity Index (ABI) can be prepared to measure and manage the agrobiodiversity across four dimensions: diets, production, seed systems and conservation. This will help the decision makers, governments, investors, companies, farmers and consumers – ensure that food systems are diverse and sustainable.
- Agrobiodiversity related business can be promoted in these hotspot areas and this will create “near-farm jobs” for women and youth and these agrobiodiversity hotspots/gene sanctuaries can be used for *in-situ*/on-farm conservation of plant and animal genetic resources.
- Agrobiodiversity rich areas need to be documented through Peoples’ Biodiversity Registers (PBRs) and suitable branding of commodities such as Geographical Indications (GI), organic certification can be encouraged for better monetary returns for the local communities.
- State wise mapping of on-farm conservation (crops) sites and their cultivation practices to be recognised. Agricultural Universities and colleges can use these sites as field sites for educating students and agro-tourism can be promoted.
- Incentives need to be provided to the farmers involved in on-farm conservation practices towards reducing the loss of agrobiodiversity resources. An on-farm conservation model needs to be developed in the agrobiodiversity hotspots. All the varieties available with the agricultural farmers and the private/public sector need to be registered with the national repositories.
- A national level database on agriculturally important plants, animals, insects, fungus and microbial organisms needs to be developed. Agroclimatic zone wise mapping of these resources along with the associated traditional knowledge is essential for the conservation of these resources.
- Landraces and traditional farmers’ varieties should be conserved through *ex-situ* and *in-situ* on-farm conservation measures and by ensuring continuous availability of their quality seed materials by promoting community seed banks across diversity rich agroecosystems.

### 5.2.4 Conservation of traditional seed varieties

Globally, the community seed banks (CSB) have been initiated at the local level to conserve the minor crops and neglected and underused species and to provide superior quality seeds. Farmers have documented traditional knowledge associated with these genetic resources in various farms with valuable traits, such as tolerance to droughts, flooding, diseases and insects; good eating qualities; market-preferred traits; long fruiting period; religious and cultural importance. In India, the CSB is practiced by the local farmers for exchanging the genetic resources from the common gene pool<sup>52</sup>.

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52. Arnab Gupta, Malavika Dadlani, Paul Quek, Prem Mathur, 2015. Community seed banks - A working Manual, Published by Bioversity International., New Delhi.



Nearly 80-90% of seeds used by smallholder farmers in developing countries are sourced from informal seed system: saved from their own crops, bought from a market or shop or exchanged with friends and neighbours. Community-level seed saving initiatives come in the form of seed huts, seed libraries, seed savers groups and many others<sup>53</sup>. In India, NBPGR is conserving the traditional varieties in gene bank located in different States. Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA) encourages communities, individuals engaged in conservation, improvement and preservation of PGRs. The local NGOs/farmers are also involved in conserving traditional seed varieties.

### Action Points

- Seed banks need to be created in each agro-climatic zone so that their regional biotic properties may be saved and this can be utilized by new generation farmers. Community seed banks at the village level need to be encouraged.
- *In-situ* conservation of farmers' varieties be ensured through establishment of community seed banks on priority basis. While distributing seeds to the farmers 5 percentage of traditional seed varieties with 100 percent subsidy can be thought off through NSC/SSC under the NFSM, NMOOP, PKVY/ bio-village and MIDH schemes so that these valuable resources can be saved and utilized by new generation farmers.
- CSBs can be encouraged in the Centres of traditional seed diverse areas that have food, fodder, nutrition, health and income value. While releasing high yield varieties/seeds, the other crop varieties also need to be considered providing importance to biodiversity.
- Hermetic storage (stored in airtight containers made of terra-cotta, metal, wood, etc.,) found to be the most effective form of seed storage is highly recommended and this can be extensively promoted.

### 5.2.5 Conservation of Crop Wild Relatives

The Bioversity International defines Crop wild relatives (CWRs) as wild plant species that are genetically related to cultivated crops. Untended by humans, they continue to evolve in the wild, developing traits - such as drought tolerance or pest resistance - that farmers and breeders can cross with domesticated crops to produce new varieties. They have been used to improve the yields and nutritional quality of crops since the beginnings of agriculture.

53. Mainstreaming Agro biodiversity in Sustainable Food Systems (Web source: [www.bioversityinternational.org](http://www.bioversityinternational.org)).



In India, nearly 326 species of Crop Wild Relatives (CWR) have developed diversity in different phyto-geographical regions. The NBPGR has shortlist CWR of 168 native crops in India, resulted in 817 taxa, belonging to 730 species which includes cereals, millets, oilseeds, fibres, forages, fruits and nuts, vegetables, spices, medicine and aromatic crops, etc.

Table 1: List of Crop Wild Relatives documented in India

S.No	Crop-group (crops)	CWR species	Taxa
1.	Cereals and millets (13)	72	83
2.	Pseudocereals (3)	13	13
3.	Grain legumes (10)	49	57
4.	Oilseeds (4)	9	10
5.	Fibres (5)	18	20
6.	Forages (16)	58	63
7.	Fruits and nuts (36)	127	144
8.	Vegetables (25)	76	87
9.	Spices and condiments (12)	50	54
10.	Ornamentals (13)	141	152
11.	Medicinal & aromatic plants (20)	70	81
12.	Plantation crops (3)	12	14
13.	Others (8)	35	39
	<b>Crops: 168</b>	<b>730</b>	<b>817</b>

Source: NBPGR, 2018

CWR are crucial for maintaining genetic diversity and their loss have serious consequences on food and nutritional security. The value of CWR for crop improvement as well as meeting the nutritional security of forest dependant local communities has been recognized globally and nationally. The genetic stocks within crop varieties, livestock breeds, and their wild relatives provide essential traits for increasing and improving agricultural production and for the development of biotechnology<sup>54</sup>.



## Action Points

- The CWR varieties (pulses, cereals, vegetable and orchids) of economic/medicinal value need be documented characterized and conserved in botanic gardens. The CWR from primary gene pool (*i.e.* those having cross ability with cultivated forms/species) of high significance need to be mapped on priority.
- The CWR available inside the protected areas need to be explored and permission need to be given for the researchers for collecting the wild germ plasm for taxonomic studies, research and conservation purposes.
- Cryopreservation of threatened plants and CWR should be prioritized; pollen and Deoxyribonucleic Acid (DNA) be cryopreserved as complimentary conservation strategies.
- Creation of CWR inventories, checklists and trait discovery and establishment of global, regional and national networks for *in-situ* CWR conservation should be carried out.
- The farmers of the forest (tribes) need to be rewarded for their efforts in conserving the CWR in the forest areas.

### 5.2.6 Conservation of livestock breeds

Livestock and poultry provide a range of products such as milk, meat, egg, fibre, transport and fuel. Globally, livestock contributes 15 species of 85% of animal food production and India possesses 12 of them. There are 183 livestock and poultry breeds available in India, which includes 42 cattle breeds, 15 buffalo breeds, 43 sheep breeds, 34 goat breeds, 7 horse breeds, 9 camel breeds, 8 pig breeds, 3 donkey breeds and 19 chicken breeds.

Table 2: Status of livestock breeds in India

Species	No of Breeds
Cattle	42
Buffalo	15
Sheep	43
Goat	34
Camel	09
Horses & Pony	07

54. Establishing Genetic Gardens for crop Wild Relatives of Spices and Condiments of India, 2016. Wild Spices Gardens Project, A draft Project Concept/July 16, 2016, prepared by MSSRF.



Pig	08
Donkey	03
Chicken	19
Gheese	1
Yak	1
Duck	1
<b>Total</b>	<b>183</b>

Source: NBAGR, 2018

Table 3: Threat status of the Livestock breeds

S.No	Name of the breed	Status	Lowest population
<b>I. Cattle breeds</b>			
1	Mewati	Endangered	14, 773
2	Pullikulam	Endangered	7,352
3	Krishna Valley	Endangered	3,462
4	Punganur	Endangered	2,772
5	Bargur	Vulnerable	14,154
6	Siri	Vulnerable	12,171
7	Vechur	Critical	1065
<b>II. Buffalo breeds</b>			
1	Toda	Endangered	3003
2	Chilika	Endangered	2599
<b>III. Sheep breed</b>			
1	Karnah	Endangered	2946
2	Poonchi	Endangered	2643
<b>IV. Goat breed</b>			
1	Attapady Black	Vulnerable	10,238

Source: NBAGR, 2018

The National gene bank and animal genomic resource bank is established for the collection of DNA samples of more than 90% of the Indian breeds of various livestock species and embryos. Under the *ex-situ* conservation cryopreserved semen doses representing important and endangered breeds of seven species of cattle, buffalo, goat, sheep, camel, equine and yark are being maintained.



## Action Points

- Designate countrywide regions as “Hotspots” for Animal Genetic Resources (AnGR) and a national/ state level watch list for the rare/threatened breeds prepared and necessary rehabilitative measures need to be taken for those species.
- To declare the livestock farms as *in-situ* conservation centres in their native tracts. Formulation of long-term breeding plans for genetic improvement *vis-à-vis* conservation of indigenous breeds. Strengthening of national gene bank through a two-tier system for *e.g.*, one at state level and these need to be networked with other livestock farms at the national level.
- Incentives need to be provided for communities who conserve indigenous breeds (*viz.*, milch, draft, buffalo, goat, sheep, camel, horses, ponies, chicken, yak, mithun, pig and donkey). It is encouraged to document the genetically pure livestock and associated traditional knowledge through PBRs to protect and check the bio-piracy for better management of these genetic resources. [Note: Some of the indigenous livestock breeds documented are: Cattle (Ongole, Umblacherry, Rathi, etc.); Buffaloes (Murrah, Nili Ravi, Surti, etc.); Sheep (Patanwadi, Nellore, Lohi, etc.); Goat (Marwari, Berari, Malabari, etc.); Pig (Desi, Ghori, etc.); Horse (Kathiawari, Marwari, Bhutia, etc.)].
- Indigenous knowledge of local and pastoral communities in utilizing the genetic diversity in their livestock need to be documented in PBRs.
- To develop a legal mechanisms for the exchange of Animal Genetic Resources and design a benefit sharing modalities for livestock keepers and gaushalas.
- The local breeders should be recognised for conserving indigenous livestock breeds (as similar to the PPV&FRA award given for conserving farmer’s crop varieties). Brood stock banks and stakeholders should be involved in the scientific management of animal genetic resources.
- Strengthening quarantine, harmonization with international standards/ guidelines revisiting export-import policy related to embryo/ semen of AnGR and to designate NBAGR as a nodal agency for the exchange of native germplasm through an effective Material Transfer Agreement (MTA).

### 5.3 Integration of horticultural mission with the Green High Ways Policy

The objective of the green highway policy is to develop an eco-friendly national highways with the participation of local community augmenting in maintaining local biodiversity. This act as a carbon sink and contribute to reduce dust pollution, add value addition, soil conservation, etc. Besides, this can also be an excellent source of fodder/ food for wild animals, these plants can be a repository of many biological control agents such as parasitoids, predators and pollinators.



## Action Points

- The horticultural crops and fruit bearing trees (mango, palm, coconut, jamun, imli, jack fruits, mahua, bel, etc.), medicinal plants, high value timber trees, biofuel based tree species, shrubs, climber and grasses can be promoted for plantation around the national and state highways.
- The local Biodiversity Management Committees (BMCs) can be employed for planting trees, maintenance and harvesting the products within their jurisdiction. This will enhance the floral as well as faunal biodiversity wealth in the urban and rural area. Integrating MIDH with the green highway projects will improve the aesthetic value, reduces the air/noise pollution levels and it will also provide livelihood security to the local community. This can be implemented through MNREGA and MIDH schemes.
- A white paper on suitable trees for planting in the highways in different agroecological region prepared. Nerium plants can be used as road dividers. It gives beautiful look to the roads and help in night time driving.
- Citizen Science, Corporate adoption, School and schoolchildren adopting a tree can be integrated into the National Green Corp (NGC) and ecoclub programmes and tax benefits for developing green way can be thought of.

## 5.4 Policy and institutional strengthening

The BD Act, 2002, defines agrobiodiversity as agriculture related species and their wild relatives. It is important that the conservation and sustainable utilization of agriculturally important plants, animals and microbes need to be effectively integrated into the biodiversity strategies, plans and programmes of the MoA&FW. Some of the issues that need immediate attention includes: (a) protection of land races/traditional crop varieties; (b) policy on conventional breeding and (c) conservation of wild relatives of crop plants, etc.

## Action Points

- Under the Section 37 of the BD Act, the concerned State Governments in consultation with the local bodies can notify the agrobiodiversity hotspots as BHSs. The PPV&FRA has already identified 22 agrobiodiversity hotspots (as given in the Annexure-1) and these hotspots can be considered by the States for designating them as BHSs.
- The list of Normally Traded as Commodities for animals, animal products can be notified under Section 40 of the BD Act.
- Guidelines need to be prepared for utilizing the National Biodiversity Funds, State Biodiversity Funds and Local Biodiversity Funds accrued as royalties and modalities need to be evolved for



sharing the benefits to the benefit claimers *e.g.*, (a) Channelizing benefits to the benefit claimers; (b) conservation and promotion of biological resources and development of areas from where such biological resources or knowledge associated thereto has been accessed; (c) socio-economic development.

- A single window clearance system can be developed by integrating National Biodiversity Authority (NBA), PPV & FRA, Patent Office, State Biodiversity Boards (SBBs), Biodiversity Management Committees (BMCs), etc. to make the entire process simple and transparent.
- Formation of BMCs in the agrobiodiversity hotspots and documentation of traditional knowledge (TK) available with rural and tribal communities, especially with women farmers through PBRs is recommended towards conserving the agrobiodiversity.
- Clarity should be brought regarding the usage of foreign microbes used by Indian companies.
- National level invasive alien species strategies need to be developed for identifying the pathways, mapping, monitoring, managing, controlling and eradicating agriculture related invasive alien species and a database of these species developed. Problematic species need to be prioritized based on risk assessment studies for creating awareness amongst the relevant stakeholders.
- National/State level quarantine measures strengthened and an early warning system of the spread of invasive species must be developed by involving Indian Council of Agricultural Research (ICAR), Indian Council of Medical Research (ICMR) and Council of Scientific and Industrial Research (CSIR) institutes towards monitoring, control and prevention of alien invasive species.
- Besides, there is a need to include the biodiversity experts in the national/ state and district level committees for implementing various missions. The NBA, SBB, and BMC representatives/biodiversity experts may be included as members in the national/state/district level committees of the MoA&FW viz., a) National Food Security Mission; b) National Mission on Oilseeds and Oil palm; c) Mission for Integrated Development of Horticulture; and d) National Livestock Mission, etc.

## 5.5 Awareness, capacity building and skill development

The awareness, capacity building and trained human resources and adoption of new technologies are essential at the field level towards conserving the agrobiodiversity. Agrobiodiversity related issues can be integrated into some of the field oriented programmes such as Farmer Field Schools for biodiversity-friendly farming; community seed banks and PBR preparatory process at the BMC level. Also farmers and youth should be made aware about the importance of agrobiodiversity through demonstration and exposure visits. The other awareness creation activities includes organising seed fairs, food fair, livestock exhibitions and these programmes should highlight the importance of varietal plant and animal diversity giving more emphasis on conserving the native varieties.



## Action Points

- Suitable curriculum for students and orientation courses for the teachers/ trainers on Agrobiodiversity issues developed through ICAR, University Grants Commission (UGC) and various central and state educational boards. Necessary capacity/training need to be provided to the officials of the State Agricultural University (SAU), ICAR Institutes, Deemed Universities/ Private Universities/Krishi Vigyan Kendras, Farmers Field School on the topics (a) Ecological agriculture; (b) soil biodiversity and its importance; (c) importance of pollinator; (d) BD Act, 2002 and preparation of PBRs; (e) Invasive Alien Species management and control and (f) biosafety issues.
- Necessary capacity building need to be initiated starting from farmers, school, colleges, gramasabha and panchayat / BMC. Some of the suggestive capacity building activities for the farmers includes: modern gene banking techniques for conserving plant and animal genetic resources, cryopreservation, molecular techniques, climate resilient crop varieties, environment friendly and good agricultural practices, waste minimisation and profit maximisation.
- Necessary skill development programmes need to be initiated on (a) taxonomic expertise to identify and maintain agrobiodiversity crop varieties; (b) incentives for entrepreneurs for manufacturing biodiversity friendly fertilizers, insecticides, pesticides using locally available biological resources etc.
- To train the tribal and indigenous women on the scientific way of conserving traditional seeds and the varietal diversity of plants and animals and also to document the indigenous knowledge available with women in conserving agrobiodiversity.
- Traditional medicinal practices need to be supported by mitigating threat-factors (habitat loss and degradation, excessive soil nutrient load, over exploitation, unsustainable use and invasive alien species), conservation through use of native landraces and animal breeds and preserving inter-generational learning of tradition (parampara) as well as documentation of traditional knowledge.

## 5.6 Finance mobilization and incentive mechanism

The Article 20 of the CBD request parties to provide financial support and incentives in respect of those national activities which are intended to achieve the objective of the convention. Some of the national financial (monetary / non-monetary) mechanism available for conserving the agrobiodiversity is elaborated below.



## Action Points

- Incentives to farmers and communities for conserving valuable genetic resources by increasing the allocations for the National Gene Fund.
- To conserve the agrobiodiversity, monetary and non monetary funding mechanism can be explored. The monetary mechanism includes: gene fund, biodiversity fund (National/State/Local), green tax for organic products, visiting fee (on-form conserved areas, BHS, community seed banks, agrobiodiversity hotspots, etc). Agro tourism can be explored extensively.
- For conserving the on-farm sites (conserved by the private owners) incentives can be provided from the Gene fund of the PPV&FRA, 2001 (State and Local) and biodiversity Funds (State/Local) as specified in the BD Act, 2002, can be explored.
- Economic incentives can be provided to the farmers switching over to ecological agriculture (organic farming, Integrated Pest Management practices, farming using native varieties).
- The non-monetary mechanism includes transfer of technology, establishing research and development, joint venture, venture capital fund and Corporate Social Responsibility. The polluter pay principle can be applied for the reclamation of the agricultural lands affected by the industrial pollution.

## 6 Conclusion



Agriculture sector plays a significant role in providing food, nutritional, livelihood security for the human wellbeing for which biodiversity provides genetic material for crop cultivation, breeding and varietal improvement of traits. In India, the Agriculture biodiversity constitutes 1500 food plants which includes 375 species of fruits, 280 species of vegetables, 80 species of tubers, 60 species of edible flowers and 60 species of seeds/nuts. Many nutritious fruits, vegetables, nuts and seeds available in the wild or in the traditional farming systems contributes immensely for improving food and the nutritional security.

India is the primary centre of origin of rice and the custodian of 811 cultivated plants and 902 wild relatives and has a vast repository of farm animals. Even though India is endowed with a huge variety (stock of animals, plants and microorganisms at genetic, species and ecosystem levels), our food basket is increasingly being confined to a few selected crops and cereals. India needs to look beyond performance and diversify with biodiversity as a key functionary of the agroecosystem.

India's agricultural production system is tilting towards the usage of chemical fertilizers and pesticides, the other related concerns includes fragmentation, excessive tillage, soil degradation, water pollution, climate change, etc which leads to the loss of agrobiodiversity. The loss of agrobiodiversity in our global food production systems is an issue of increasing concern, recognised by the Rio Convention on Biological Diversity and the Sustainable Development Goals of the United Nations. When we lose agricultural biodiversity, we also lose the option to make our diets healthier and our food systems more resilient and sustainable.

For doubling the agricultural productivity it is important to increase the agrobiodiversity wealth of the country. FAO had estimated that more than 75 percent of global crop diversity has disappeared irrevocably over the 20th century. With the advent of modern agriculture, numbers of locally adopted crop varieties were replaced by genetically uniform, high-yielding



modern varieties. In India, that once grew 30,000 rice varieties, has now reduced significantly and many local cultivars and land races have been restricted to small areas, which is a great concern in terms of narrowing down of the genetic base.

To address the loss of biodiversity, the present study has suggested few recommendations to integrate biodiversity concerns into the agricultural sectors towards enhancing the agrobiodiversity wealth of our country. Some of the suggested recommendations are: to promote ecological agriculture (*viz* organic farming, integrated pest management, mixed, farming etc.); conservation of agrobiodiversity hotspots; provide incentives for on farm conservation practices and for conserving indigenous breeds; promote native pollinators; conservation of traditional seed varieties and crop wild relatives; to revisit incentives provide for chemical fertilizers, pesticides and herbicides; documentation of TK associated with sustainable agricultural practices & management and strengthen the implementation of Biological Diversity Act. By implementing these recommendations, it is assured that the food, nutritional and livelihood security is attained and also the Aichi Biodiversity targets of the CBD and SDGs can be achieved.

For implementing these recommendations, a matrix has been prepared along with the action plan and the responsible agencies (Annexure-2). It is suggested to implement the proposed recommendation by the concern ministry through its policies, programmes, plans, projects towards conserving the agrobiodiversity resources available in our country for the benefit of the human wellbeing.



## Annexure I

### Agrobiodiversity hotspots

1	Cold desert region	12	Lower Gangetic plains
2	Western Himalaya	13	Gangetic delta region
3	Eastern Himalaya	14	Chotanagpur region
4	Brahmaputra valley	15	Bastar region
5	Khasia-jaintia-Garo hills	16	Koraput
6	North-eastern hills	17	Southern Eastern Ghats
7	Arid western region	18	Kaveri region
8	Malwa Plateau and central highlands	19	Deccan region
9	Kathiawar	20	Konkan region
10	Bundelkhand	21	Malabar region
11	Upper Gangetic plains	22	Island region (A&N and Lakshadweep)

Source: <http://www.plantauthority.gov.in/index.htm>

## Annexure II

### Recommendations, Initiatives and Responsible Agencies

S. N.	Recommendations	Suggested Action points	Suggested Missions/ Schemes/ programmes agencies
<b>5.1 Promote ecological agriculture</b>			
		<ul style="list-style-type: none"> <li>• Policy on “Ecological agriculture practices prepared”.</li> <li>• Incentives for biodiversity friendly practices.</li> <li>• To promote native pollinator species.</li> </ul>	<p><b>Mission:</b> NFSM, MIDH, NMSA, PKVY, and NPOF.</p> <p><b>Agencies:</b> MoA&amp;FW, KVKs, State Department of Agriculture, Agricultural Universities, MGNREGS, APEDA.</p>
<b>5.2 Conservation of agrobiodiversity</b>			
5.2.1	Conservation of on form practices and Agrobiodiversity hotspots	<ul style="list-style-type: none"> <li>• Globally significant agrobiodiversity significant areas identified in India.</li> <li>• Agroclimatic zone wise mapping of agriculturally important areas prepared.</li> <li>• Agrobiodiversity index prepared for the agrobiodiversity hotspots.</li> <li>• State wise mapping of on-form conserved areas and action taken towards conserving these areas.</li> <li>• Documentation of Indigenous varieties through PBRs and branding.</li> <li>• Incentives provided for the farmers towards conserving the agriculturally important (plants/ animals) species.</li> </ul>	<p><b>Mission:</b> NFSM and NLM.</p> <p><b>Agencies:</b> MoA &amp; FW, State Department of Agriculture, PPV&amp;FRA, NBA, SBBs, BMCs, Local NGOs, Universities, ICAR-NBPGR/ NBAGRs/ MGNREGS and State Forest Departments.</p>



5.2.2	Conservation of traditional seed varieties	• National database on traditional seed varieties developed.	<b>Agencies:</b> MoA & FW, State Department of Agriculture, NBPGR, NSC, SSC, Local BMCs, NGOs and CSBs.
		• Provide incentives/subsidy for distributing traditional seeds through NSC and SSC.	
		• Localised seed storage techniques need to be upgraded (e.g. Hermetic storage).	
		• Community seed bank encouraged.	
5.2.3	Conservation of Crop Wild Relatives	State wise mapping and documentation of CWR.	<b>Agencies:</b> NBPGRs, State Department of Agriculture, SBBs and BMCs.
		Mapping of CWR available inside the protected areas.	
		Cryopreservation of threatened plant and CWRs.	
5.2.4	Conservation of livestock breeds	Prioritise conservation of rare/ threatened local/native breeds by providing incentives.	<b>Agencies:</b> MoA&FW, State Department of Agriculture ICAR-NBAGR DAH, DAC&FW Local NGOs and BMCs.
		Preparation of watch list (state/ national). and to take rehabilitative measures for endangered/threatened species.	
5.3	Integration of horticulture mission with the Green High way policy	Usage of horticultural plants in the road highways and urban landscapes.	<b>Mission:</b> MIDH <b>Agencies:</b> National Highways Authority of India, State Departments of Agriculture, SBBs, BMCs and Local NGOs.
		Involvement of BMCs in plantation, maintenance, harvesting and benefits generated.	
		A white paper on planting suitable horticultural plants/trees in the national/state highways developed.	
<b>5.4 Policy and institutional strengthening</b>			
	a) Compliance of the BD Act.	Notification of Agrobiodiversity hotspots as BHSS.	<b>Agencies:</b> NBA, MoEF&CC, MoA&FW, SBBs, BMCs, NBA and State Departments of Agriculture.
		Preparation of NTC for animals and animal products.	
	b) Strategy on Invasive Alien Species	• Strategy for the control and management of Invasive alien species developed.	<b>Agencies:</b> MoA & FW and MoEFCC.
		Inclusion of biodiversity experts in the agriculture related schemes and integration of biodiversity concerns into these schemes.	<b>Mission:</b> NFSM, NMOOP, NMSA, NBAIM, NLM and MIDH. <b>Agencies:</b> NBA, SBBs & BMCs.



## Annexure III

### List of reviewed initiatives

Reviewed Mission/ Programme/ Policy	Biodiversity concerns	Gap	Recommendations
<b>1. National Food Security Mission</b>			
	Hybrid seeds of rice, wheat, pulses, cereals are distributed by National Seed Corporation and State Farms Corporation of India.	Traditional seed varieties of the food crops are not adequately conserved.	Provide incentives/subsidies for the distribution of 5% traditional variety seeds towards conserving the local/native varieties.
<b>2. National Mission on Oilseeds and Oil Palm</b>			
	Seed mini kit (20 kg seed of ground nut; 8 kg seed of soybean; 2 kg seed of rape seed and mustard, sun flower, safflower, linseed, castor and one kg of sesame and niger each) is provided to the farmers free of cost.	Traditional oil seed varieties and Tree Borne Oilseeds are not adequately conserved.	Incentives/subsidies can be provided for conserving native varieties of oil seeds and tree borne oilseeds through seed garden.
	Seed storage bins provided.	Farm saved seed deteriorates, if they are not stored with adequate care and safety.	Hermetic storage found to be the most effective form of seed storage is highly recommended.
<b>3. Mission for Integrated Development of Horticulture</b>			
	Pollination support through Bee Keeping (production of nucleus stock, production of bee colonies, bee breeder, honey bee colony and bee hives).	Only honey bee is promoted for pollination.	Along with honey bee, other native pollinator species can also be promoted viz moths, wasps, beetles, etc under the MIDH.  Also the native bees such as Amegilla zonata, Hoplonomia westwoodi, Amegilla zonata and Hoplonomia westwoodi can be promoted.  Ecological infrastructure such as hedges, pond, beetle bank and other habitats can be created for providing habitat for pollinators in the agricultural landscape.
	Pheromones/ bio-pesticides and planting of 100 neem trees is provided under the Farmers Field School (FFS) programme.	Only neem tree plantation is promoted under FFS.	Wild/native species having pesticide properties can be identified and characterized.  The women entrepreneurs can be encouraged for manufacturing localised/native organic pesticides and insecticides.



<b>4. National Mission on Sustainable Agriculture</b>			
	Rainfed area development (crops, horticulture plants, livestock and fishery based)	The integration of farming practices is based on the availability of rainwater.	The Satoyama initiative can be adopted under the mission for promoting sustainable agriculture. Under this, home garden can be promoted which can integrate trees with field crops, livestock, poultry, medicinal plants, fish culture. This integrated practice will enhance the soil health and organic nutrient of the soil.
Soil Health Management	SHM aims at promoting Integrated Nutrient Management (INM) through judicious use of chemical fertilisers including secondary and micro nutrients in conjunction with organic manures and bio- fertilisers for improving soil health and its productivity.	Chemical composition of the soil is tested (PH, EC, OC, N, P, K, S, Zn, B, Fe, Mn, Cu).	Recommended to include the biological parameters (Soil macro fauna: <i>e.g.</i> , earthworms, insects etc.) in the SHC.
	Climate Change Adaptation and mitigation	Dissemination of rain fed technologies, sponsoring research projects and capacity building, training and networking.	Conservation of traditional/ locally available PGR and AGR, which can adopt climate change.  To promote salt, drought resistant varieties which can adopt climate change.
<b>5. National Livestock Mission</b>			
	Conservation and genetic up gradation of indigenous breeds of livestock's.	Watch list of native varieties are not in place.	Documentation of native/ indigenous breeds at the local/ state level and watch list need to be prepared for rehabilitating endangered species.
<b>6. Green Highways (Plantation and Maintenance) Policy, 2015</b>			
	To develop an eco- friendly national highways with the participation of local communities.	BMCs are not included in the Green high way policy	To integrate horticulture mission with the Green Highway policy. Youth's, women and BMCs can be integrated in plantation, maintenance and harvesting of plants in the state and national highways.



## Annexure IV

### Prioritization of Recommendations

S. No	Recommendations	Action	Responsible agencies
<b>1 Compliance of BD Act</b>			
(a)	Guidelines prepared for the utilization of NBF, SBF and LBFs.	Preparation of Benefit sharing Guidelines by NBA.	MoEFCC, NBA and SBB.
(b)	Notification of agrobiodiversity important sites as BHSs.	Identification and notification of BHSs by the State Governments.	State Governments/ UTs, SBBs, BMCs and PPV&FRA.
(c)	List of NTCs prepared for animals and animal products.	List of animals and animal products to be notified as NTC.	MoEFCC and NBA.
(d)	Identification, prioritization, control and management of agriculture related Invasive Alien species.	Listing the agriculture related Invasive alien species and prioritization.	MoEFCC, NBA, SBB, BMCs, ZSI, BSI, etc.
<b>2</b>	On-farm conservation	Mapping and documentation of potential on-farm areas and incentive need to be provided for conserving the local land races.	SBBs, BMCs, MoA&FW and PPV&FRA.
<b>3</b>	Conservation of Traditional Seeds	National level database and mapping of traditional seed varieties developed. Seed storage mechanism need to be enhanced.	SBBs, BMCs and NGOs.
<b>4</b>	Conservation of Livestock breeds	To prepare a state level watch list for the rare/threatened breeds.	MoA&FW, ICAR- NBAGRs, SBBs and BMCs.
<b>5</b>	Ecologically intensified agricultural farming.	Policy need to be formulated by the respective ministry by involving relevant stakeholders.	MoA&FW, NBA and MoEFCC.

## Annexure V

### List of Participants who attended the Policy Dialogue on Mainstreaming Biodiversity into the Agriculture Sector

1	<b>Professor Ramesh Chand</b> Member NITI Aayog, New Delhi - 110001	2	<b>Dr. Amita Prasad</b> Additional Secretary Ministry of Environment, Forest and Climate Change, Government of India New Delhi - 110 003
3	<b>Dr. B. Meenakumari</b> Chairperson National Biodiversity Authority (NBA) TICEL Biopark, Chennai-600 113	4	<b>Dr. P.L. Gautam</b> Former Chairman NBA and Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA) Himachal Pradesh - 176041
5	<b>Dr. R.S. Rana</b> Chairman Expert Committee on Agrobiodiversity NBA, Chennai	6	<b>Dr. Ajay Parida</b> Director Institute of Life Sciences, Bhubaneswar, Odisha - 751023
7	<b>Dr. Ravi Khetarpal</b> Advisor Centre for Agriculture and Biosciences International (CABI) Pusa Complex, New Delhi – 110 012	8	<b>Dr. Krishna Kumar</b> Director South Asia Coordinator Bioersivity International New Delhi 110 012
9	<b>Shri R.B. Sinha, IAS</b> Joint Secretary (RFS) Ministry of Agriculture & Farmers Welfare (MoA&FW) New Delhi 110012	10	<b>Dr. V. P. Singh</b> World Agroforestry Centre Dev Prakash Shastri Marg, Pusa Campus New Delhi 110012
11	<b>Dr. Mruthyunjaya</b> Former National Director National Agricultural Innovation Project Bangalore-560064	12	<b>Dr. R.C. Agrawal</b> Registrar General PPV&FRA, MoA&FW New Delhi-110 012
13	<b>Dr. Ravi Prakash</b> Registrar PPV&FRA, MoA&FW New Delhi-110 012	14	<b>Dr. Sudhir Kochhar</b> Member Expert committee on Agrobiodiversity NBA, Chennai
15	<b>Prof. Dinabandhu Sahoo</b> Director Institute of Bioresources and Sustainable Development Imphal-795 001	16	<b>Dr Kuldeep Singh</b> Director National Bureau of Plant Genetic Resources (NBPGR), ICAR, MoA&FW New Delhi 110012



17	<b>Dr. Chandish R. Ballal</b> Director National Bureau of Agricultural Insect Resources, Bengaluru - 560 024	18	<b>Dr. N. Anil Kumar</b> Director M. S. Swaminathan Research Foundation Kerala – 673577
19	<b>Dr. J.C. Rana</b> Head Genetic Resources Evaluation Division NBPGR, New Delhi 110012	20	<b>Alka Tomar</b> President Centre for Environment Communication New Delhi
21	<b>Dr. Pratibha Brahmi</b> Head Germplasm Exchange NBPGRs, MoA&FW Pusa Campus, New Delhi 110 012	22	<b>Mr. Raj Ganesh</b> Legal Advisor PPV&FRA, MoA&FW, New Delhi-110 012
23	<b>Mr. C.M. Pandey</b> Additional Commissioner Natural Resource Management Division Krishi Anusandhan Bhawan-II, MoA&FW New Delhi - 110 012	24	<b>Dr. T. M. Shivalingaswamy</b> Principal Scientist Agricultural Entomologist National Bureau of Agricultural Insect Resources Bengaluru - 560 024
25	<b>Dr. Tejveer Singh</b> Scientist Indian Grassland and Fodder Research Institute, Jhansi – 284 003	26	<b>Dr. Dushyent Gehlot</b> MoA&FW Government of India New Delhi 110012
27	<b>Mr. Gaurik</b> Reporter Geography and You Bhikaji Cama Bhawan, Bhikaji Cama, Place, RK Puram, New Delhi - 110066	28	<b>Mr. Pranav Jain</b> Reporter Geography and You Bhikaji Cama Bhawan, Bhikaji Cama, Place, RK Puram, New Delhi - 110066
29	<b>Shri. Muktannalal</b> Patanjali Peeth Haridwar Uttarakhand	30	<b>Dr. Rashmi Sain</b> Senior Technical Assistant RFS Division, DAC&FN MoA&FW, Krishi Bhawan, New Delhi
31	<b>Ms. Namrata Singh</b> Science Associate CABI, New Delhi - 110 012	32	<b>Dr. B.D. Sharms</b> Himalayan Research Group Shimla, Himachal Pradesh
33	<b>Dr. Prakash Nelliya</b> Fellow Centre for Biodiversity Policy and Law NBA Chennai-600 113	34	<b>Dr. Ritesh Joshi</b> Scientist D MoEFCC, Government of India New Delhi – 110 003
35	<b>Dr. C. Palpandi</b> Scientist C MoEFCC, Government of India New Delhi – 110 003	36	<b>Dr. C. Thomson Jacob</b> Consultant (Biodiversity Policy) CEBPOL, NBA Chennai – 600 113 Convener of the Policy dialogue on Mainstreaming biodiversity into Agriculture sector



## Annexure VI



Photo 1: Discussions during the policy dialogue on Mainstreaming biodiversity into agriculture sector



Photo 2: List of participants during the one day Policy dialogue on Mainstreaming biodiversity into Agriculture sector held on 20<sup>th</sup> January, 2017 at Pusa Complex, New Delhi.



# About CEBPOL

Government of India in collaboration with the Norwegian Government has established "Centre for Biodiversity Policy and Law (CEBPOL)" at the National Biodiversity Authority (NBA), an autonomous and statutory body of the Ministry of Environment Forest and Climate Change towards strengthening of expertise in Biodiversity Policy and Law in India. This programme is executed by the NBA in collaboration with Norwegian Environment Agency through the Royal Norwegian Embassy, New Delhi, India.

The Centre aims to provide advice and support to the Government of India and Norway on Biodiversity Policy and Law related issues including complex negotiations on Access and Benefit Sharing and Traditional knowledge as well as governance issues relating to biodiversity at the National and International level. The Centre proposes to help NBA in the effective implementation of International agreements on conservation, sustainable use and the associated access and benefit sharing components of it.

CEBPOL is set up as a specialized Centre of Excellence in Biodiversity Policy and Law to network, organize and consolidate expertise on issues of Biodiversity Policy and Law in India and Norway. The Centre, located at NBA, would function as an independent think tank on Biodiversity Policy and Law. In addition, CEBPOL aims to contribute to the effective implementation of the Biological Diversity Act 2002 and Rules 2004.

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