Goa State Biodiversity Strategy and Action Plan (GSBSAP) - 2022

Baseline Status, Suggested Actions, Way Ahead and Role of Public, Academia and other Stakeholders for each individual sub-committee for preparation of Goa State Biodiversity Strategy and Action Plan (GSBSAP)

PRESENTATION ON VARIOUS SECTORS AND PRELIMINARY INFORMATION

Convention on Biological Diversity

Ministry of Environment, Forest and Climate Change, Government of India

National Biodiversity Authority, India 2003

Goa State Biodiversity Board

Government of Goa

WHAT IS BIOLOGICAL DIVERSITY?
"जैवविविधता"

Bio= living , Diversity = variety

Section 2: Definition

(b) *'Biological diversity' – means the variability among living organisms from all sources and the ecological complexes of which they are part and includes diversity within species or between species and ecosystems*

Levels of Biodiversity….

Genetic

- Genes within same species show variation
- E.g. Colour & sizes of Butterfly, Rose

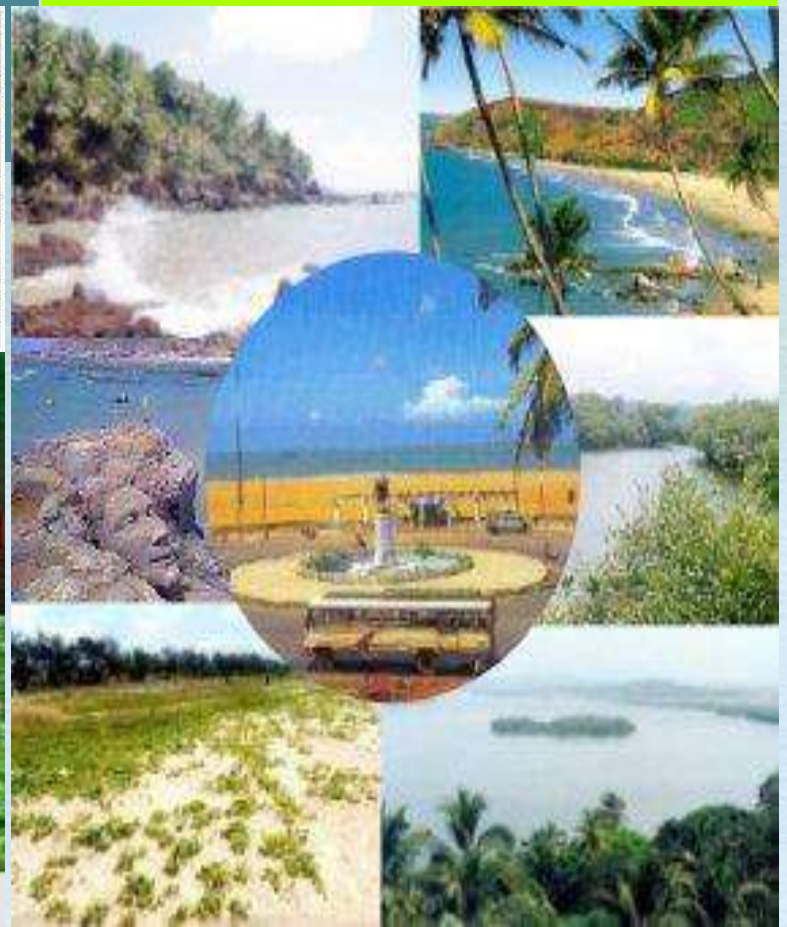
Species

- Represents species richness & abundance in a community
- No. of plants, animals, birds in an area.

1. Snow Leopard 2. Royal Bengal Tigers
3. White Tigers 4. Elephant

Ecosystem

- Diversity in complex systems in physical, ecological, food web, nutrient cycling
- Diversity in forest




Agrobiodiversity and associated areas

Dr.A. R. Desai & team

Baseline / Scenario of Agro-Biodiversity Sector in the State of Goa

- Konkan Goa, being the part of Western Ghat Biodiversity Hotspot, has enormous Biodiversity in flora and fauna which encompasses the wealth of Agro-biodiversity also.
- Goa State's Agro-Biodiversity spans across total area of about 3702 square km under different topographical situations like Coastal plains including estuaries, Foot hills and Hilly terrains.
- Nevertheless, Goa's Agro-Biodiversity is flourishing under the annual average precipitation of about 3000 mm, it is also under the onslaught of natural calamities and the threat of excessive anthropogenic activities.
- On one hand, Goa's Agro-Biodiversity is catering to the needs of the state, while on the other hand, it is under the exploitative demographic pressure of 15.3 lakh population besides the manifold enormous demographic pressure of dynamic tourists population.
- Though Agro & Allied sector Biodiversity contributes <5 % to the State's GDP, share of Agriculture & allied sector in GVA (Gross Value added) at current prices is Rs 55,06,000 (Economic survey for 2021-22, Govt of Goa) for 2021-22 and forms a fulcrum for the sustainable Development Goal (SDG) for the state.

- 28 traditional varieties of rice are documented by ICAR-CCARI and Goa university. Jaya and Jyoti are two popular rice varieties in Goa . Some local varieties like Korgut, Asgo, Muno, etc are tolerant to salinity
- The rice germplasm collections comprising of landraces (133) and wild rice (20) is being maintained at ICAR-CCARI, Old Goa. ICAR-CCARI has developed Goa Dhan-1, 2, 3, 4 suitable for Khajan lands ecosystem.
- Apart from above, minor millets like finger millet or nachni (Elusine coracana) and vari millet or little millet (Panicum sumatrense) are also traditionally cultivated. Alasando , a bold seeded cowpea , ground nut , sesamum are other crops. Wild types of sesame and castor are abundantly seen.
- There are many varieties of horticultural crops including 77 mango varieties are reported earlier 77 mango varieties were reported earlier, Cardozo Mankurad, an elite selection is registered with NBPGR, New Delhi, local banana varieties like Myndoli (GI Registered), Saldatti, Velchi, Amti, Sakri, Savarboni, Rasbali and other crops like Karonda, Guava, Tamarind, Ber, Chunna (Zyzipus sp), Kanera, Bimla, Carambola, Wax apple, Rose apple, Rambutan etc.
- The plantation crops include cashew (Goa cashew -1, 2, 3 &4 are released for commercial cultivation in Goa and suitable for adjoining Konkan regions), coconut, arecanut , chara and species of spices like black pepper, nutmeg, kokum, turmeric, ginger etc.
- Tuber crops like Katekanaga, Greater Yam, Karando, Jhad kanaga, Sweet potato, Coclcasia Spp (Alu madi, Dhave alu, Taro bhaji) etc. These are is largely maintained and used for domestic consumption as well as livelihood security.
- Vegetable crops include Brinjal (Local varieties: Agassaim & Taleigaon), Chilli: Kholla local, Harmal chilli (Both GI Registered), Okra: Local types : Seven ridged, Mangrove fern : Akur , Chekurmanis etc.

Nachni

Vari millet

Biodiversity of flower/ ornamental crops

- Jasmine : Jayo, Jui, Mogri
- Crossandra : Aboli, Ratn aboli, Wild types,
- Chrysanthemum : Shevati types
- Dasvan : Hibiscus : rosa sinesis
- Champaka : (*M.Chamapaka*)
- Temple tree: *Plumeria alba*
- Surangi (*Mammea suriga*)
- Ovala : *Mimusops elengi*
- *Chaffi: Nagchampa (*Messua ferra*)*
- Nagalinga pushpa : (*Couropita guianensis*)
- Rat rani: (*Cestrum nocturnum*)
- Four O clock plant : *Mirabilis jalapa*
- Brahma Kamal : *Saussurea obvallata*
- Anant gandhraj fool : *Tabarnaemontana divaricata*
- Parijat : *Nyctathus arbor-tristis*
- Ashoka : *Saraca indica*
- Amaltas : *Cassia fistula*
- Water Lily
- Lotus : *Nelumbo nucifera*
- Introduces
- Kaner: *Nerium oleander*
- *Ixora & Mussaenda*
- Gotla : *Barleria spp*
- Balsam : *Balsamina impatiens*

Suggested Actions/ Way Ahead

- Characterization and Documentation of the location specific genetic resources.
- HRD programmes for creating awareness about the importance of local / regional biodiversity among the general public.
- Awareness about the biodiversity resources among the school children at the early stage through various programmes in schools and educational institutes
- Enlightenment about the nutraceutical importance linked to the traditional consumption pattern.
- Community conservation of the resources for the future generation.
- Streamlining of economic value chain and sustainable marketing of the produce/products.
- Promotion of organic practices for sustainable conservation.
- Policies and programmes for promoting nutraceutical minor millets, minor fruits & vegetables need to be formulated and executed for healthy future
- IPR protection and thereby benefit sharing needs to be emphasized to create awareness among the gullible public and responsible stake holders.
- Agro-Biodiversity based branded Goa products through secondary agriculture may be promoted which will not only play vital role in agrobiodiversity conservation at community level but also ensures livelihood security through benefit sharing among the stakeholders.

Expected contributions from

Public :

- Local public may bring to the notice of the BMC (PBR)/ any member of Agrobiodiversity/ Goa Biodiversity Board team, about the local germplasm (Agro & allied Biodiversity) resources
- Local public also has to play vital role for *in situ* conservation of Agrobiodiversity for the posterity and sustainable utilization

Academia / Scientific Community / Others

- Characterization & documentation of agrobiodiversity profile
- Conservation and /or Sustainable utilization for further enhancement of bioresources and restoration of the same in the aftermath of the natural catastrophic events.
- Documentation of Agrobiodiversity related traditional festivals (eg. Konsachem fest, Matoli, Zayo fest of Mardol, Touchem Fest, etc)

Microbial Diversity

Dr.Nandkumar Kamat & team

Baseline/ Scenario/ Current Status of Sector in the State of Goa

- A lot of work on microorganisms, especially human pathogens was done by pioneer microbiologist Froilano De Mello (1905- 45) during Portuguese colonial rule. Publications after Goa liberation reveal than 1000 species of microorganisms comprising archaea,eubacteria,Actinobacteria,cyanobacteria, unicellular asco- and basidiomycetous yeasts, protozoa and micro and macrofungi including several novel taxa reported from the state.
- Traditionally local people could distinguish at least 50-60 species of macrofungi because of knowledge of ethnomycology or use of wild edible and medicinal macrofungi.

- Only a small proportion of viral and microbial biodiversity has been assessed so far and strategies and action plans for assessment of all viral and microbial species and viral and microbial genetic diversity in different ecosystems, habitats and microhabitats needs to be still carried out systematically .

<u>Status of Microbial Diversity</u>

- Viral diversity
  Viral diversity (DNA and RNA) about 200
- Microbial diversity
- Archaea- 100 species
  Cyanobacteria- ~100 species, Eubacteria- ~200 species , Actinobacteria- ~100 species
- Myxomycetes ~25 species
- Microfungi or mitosporic fungi ~500 species
- Unicellular yeasts- about 200 species
- Filamentous Macrofungi including mushrooms of asco and basidiomycotina -~500 species
- Lichens about 60 species
- Protozoa about 10 species

Suggested Actions/ Way Ahead

- Systematic understanding of present knowledge of all local ecosystems, natural habitats, microhabitats , their status of conservation, identification of threats and potential for further research with top priority for all soil types, sediments, rocks, minerals, aquatic habitats, salt pans, caves, waterfalls, springs, fountains etc. Special attention to be paid to bygone biospheres and metabiospheres by drip drilling upto groundwater level. Mapping microbial fossil diversity.

- Systematic understanding of known microbial diversity from all published sources, unpublished reports, dissertations, local knowledge, identification of gaps in knowledge and plans to fill these gaps by systematic surveys and exploration of the microbial habitats

- Systematic understanding of genetic diversity of Viruses and microorganisms from different habitats and in situ and ex situ strategies and action plans needed for their long term conservation. In Viruses special attention to map all reservoirs of zoonotic viruses especially bats.

- Planning for Goa State All Microbial Taxa Biodiversity Inventory (AGMTBI), Structural and functional Metagenomic studies using e DNA, getting correct understanding of non culturable species, Genomic sequencing, Molecular identification, DNA Bar coding and identification of useful microbial species and their genes, bioprocesses and bioproducts

Expected contributions from

- Public
  - Collection of ethnomycological knowledge and information on various types of beneficial and non beneficial microorganisms in agro-horticulture, fermentations, medicine, drugs, cosmetics, food preservation and processing. This can be done through BMCs and direct interviews.
  - Demystification of local microbial fermentation based processes and techniques to identify the microorganisms possibly involved. To be done through contacts.
  - People's knowledge of unique local microbial habitats with which microbial ecologists may not be familiar. This is location specific. E.g. underground edible macroascomycetes like Tuber sp.
- Academia / Scientific Community / Others (Mention if specific missed out)

Nature of work on Microbial Diversity being done and work already available in publications to be made available to this group and ideas for future work. All unpublished reports, dissertations, thesis to be made available by all govt aided agencies to this group.

Plant Biodiversity including medicinal plants

Dr. M K Janarthanam & team

Current status

- Goa is endowed with rich and abundant flora but a complete flora for the state needs to be carried out.
- There is scope of preparation of herbarium and adopting digital technologies to preserve and record the flora.
- Certain ecosystems that are threatened needs special focus for example, flora of plateaus, grassland biodiversity, sand dunes etc.
- Invasive species are eliminating native species.
- There is a need to bring wild edible/useful species under cultivation
- Unplanned tree plantation in open areas (greening) is a direct threat to herbaceous species.
- Disconnect between people and plants is increasing the threat
- Baseline phenology data not available for climate change studies

Suggested Actions/ Way Ahead

- An approach wherein indigenous, endemic and local species in relatively less altered area is recorded, needs to be adopted when preparing PBR.
- A complete Flora of State of Goa with local names, keys for identification, photographs in English, Konkani and Marathi both in book and digital forms (including free pdf and web versions) shall be broughtout.
- Separate Floras of protected areas (eg. Flora of Bhagwan Mahavir (Molem) National Park and Adjoining, Goa) and local areas (plateaus) shall be brought out.
- A herbarium shall be established (or Goa University herbarium shall be strengthened). To begin with complete collections from few panchayats from across Goa can be attempted.
- Periodic and planned eradication of invasive species shall be carried out while ensuring that local landraces are preserved.
- Wild edible resources shall be domesticated/brought under cultivation.
- Tree plantations in natural open areas (lateritic plateaus) shall be regulated.
- Regular field exposure shall be given to the people of all walks of life to being awareness.
- Phenological studies on selected plants to be started to create baseline data.

Expected contributions from

- Public
  - Participating in eradication of invasive species
  - Helping in the preparation of herbarium
  - Participating in field walks and documentation
  - Resisting unscientific tree planting
  - Helping in domestication attempts
  - Contributing through Citizen Science
- Academic/Scientific community
  - Scientific documentation including herbarium preparation
  - Providing scientific inputs to public in partnership mode
  - Publishing popular books
  - Guiding in eradication of invasive species
- GSBB
  - Taking up conservation programs for specific flora.
- Forest Department
  - Including more local indigenous species in their nurseries.
  - Facilitating permissions for management of invasive species, simplification of entry procedures for researchers etc.
  - Joint efforts with local communities

Avifauna and Entomofauna

Shri. Parag Rangnekar & team

Baseline/ Scenario/ Current Status of Respective Sector in the State of Goa

- Birds: 478 species documented
- Butterflies: 254 species reported
- Odonates: 93 species reported
- Hymenoptera (Wasps): 70
- Hymenoptera (Ants): 134
- Mantodea: 16
- Arachnida: 126

Many species are Endemic to the Western Ghats, included in the Schedules of the WPA, 1972 and also Globally Threatened. Distribution and habitats better known only for avifauna.

Suggested Actions/ Way Ahead

- Mapping of secondary data including citizen science portals and social media
- Consultations with wider scientific community
- Identification of Zones of Conservation Importance (ZCI)
- Identification of Species of Conservation Priority (SCP)
- Defining strategy for long-term monitoring of avifaunal populations at ZCI including PA's
- Habitat monitoring strategy of ZCI including PA's from avifaunal and entomofauna perspective
- Defining protocols for population monitoring and distribution mapping of SCP
- Defining conservation strategy for SCP and ZCI

Expected contributions from

- Public
  - Involvement in data collection
  - Monitoring of neighborhoods (Citizen Science Networks)
  - NGO/CBO involvement
- Academia / Scientific Community / Others (Mention if specific missed out)
  - Documentation of entomofauna and other arthropods
  - Maintaining a repository of specimen for scientific as well as educational purposes
  - Setting up long-term monitoring protocols
  - Involving students community in data collection and handling
  - Extension/Communication of scientific research



Climate change, biodiversity and budgetary aspects

Dr Rajiv Chaturvedi (BITS), Dr Sushant Naik (CSIR NIO) & team



Baseline/ Scenario/ Current Status of Respective Sector in the State of Goa

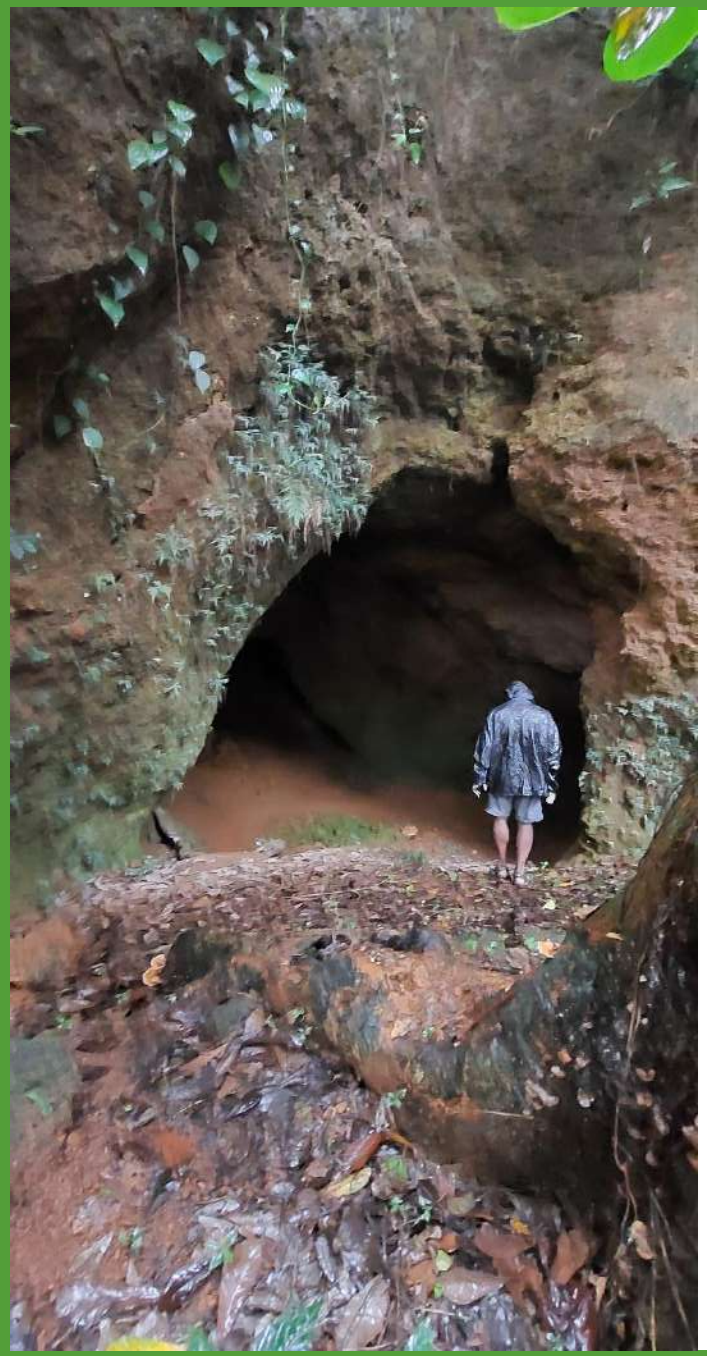
- Goa's mean annual temperature has increased by over 1°C since the beginning of the 20th century till date, much of it during 1990-2018 period. Mean annual rainfall in Goa has increased by 68% over the same period.
- Extreme temperature and extreme rainfall events are projected to further increase in the state. Increase in **extreme rainfall events** could jeopardize rich biodiversity in the state.
- Much of Goa's forest cover will be impacted adversely by impacts of climate change by 2050, if current trend continues.
- Livelihood dependents mainly on *khazan lands* and low lying ecosystems including riparian ecosystems are in particular the immediate and most vulnerable groups.
- The flood vulnerability analysis from the state reveals that 14.73% of the land is under 15meter elevation, much of it in the coastal zones, and are severely vulnerable to flooding both from extreme rainfall events and sea-level rise. This includes the Mangrove ecosystems which are of ecological and socio-economic significance and are most vulnerable to rising sea level.
- Warming Ocean, Sea Level Rise, changes in precipitation, ocean acidification due to increased CO2 also affect corals which are biodiversity hotspots.

Suggested Actions/ Way Ahead

- Studies on impact of climate change on bioindicator species needs to be carried out.
- Studies on impact of different levels of projected climate change on vulnerable floral and faunal diversity in Goa including insects, reptiles, benthic organisms, fishes etc. as well as specific ecosystems such as Mangroves and Corals.
- Carrying out the climate vulnerability assessment of nature dependent livelihoods like impact of lower fish stock, due to rising temperatures, on fishing communities.
- Assessment of the response of climate vulnerable crops to changing climatic conditions for taking necessary actions for their preservation.
- Listing the ways in which flora and fauna in the state is adapting to ongoing climate change (i.e. exemplified by 1C rise in temperature).
- Collection and documentation of best practices and adaptation options that are being recommended and applied elsewhere to safe guard biodiversity in our state.

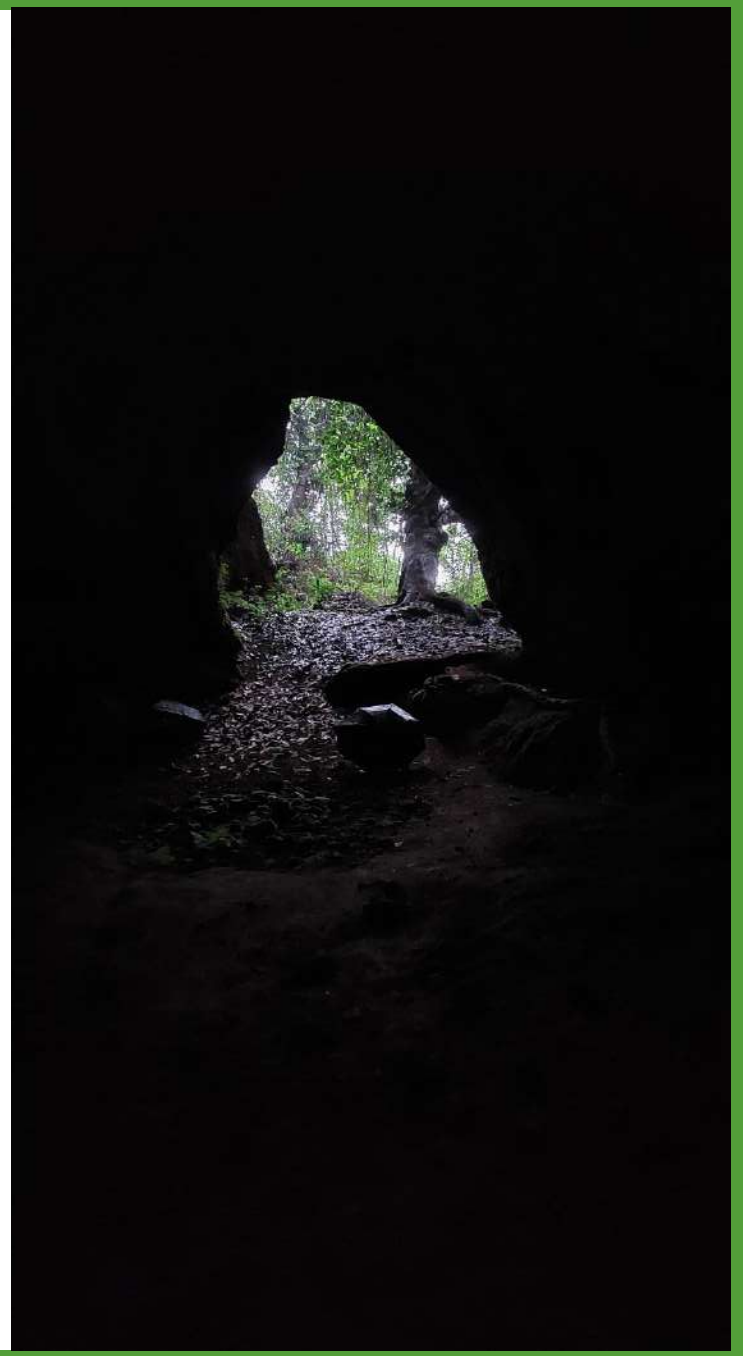
Expected contributions from

- Public
  - People's perception of climate change in Goa.
  - People's observation of changes in climate for example extreme rainfall or increased temperatures.
  - People's observation of Climate Change on biodiversity- for example, how are plants and animals affected due to extreme temperatures.
  - Documentation of indigenous knowledge and practices on safeguarding of biodiversity
  - Suggestions from public, experienced villagers on how can biodiversity be safeguarded from climate change.
  - General public needs to be involved in climate diplomacy.
  - Behavioural based solutions in people needs to be promoted to reduce the impact of climate change
- Academia / Scientific Community / Others (Mention if specific missed out)
  - Research by scientists in certain sector found to be particularly vulnerable to climate change.
  - Institutes like ICAR,WRD should share their findings to public
  - People oriented research that directly contributes to their reduction in carbon footprint



Forest Biodiversity and Other Ecosystems

Dr Manoj Borkar & team



Forest Biodiversity

- Goa is a Western Ghats state having approximately 34.75% of its geographical area under forest cover of which about 62% has a 'Protected Area' status.
- One National Park and six Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.33% of its geographical area.
- Recorded Forest Area (RFA) in the State is 1,225 sq km; of which 253 sq km is Reserved Forest and 972 sq km is Unclassified Forests.
- With five forest types (Champion and Seth, 1968), Major portion of the vegetation in Goa belongs to plateau
- vegetation along undulating terrain and hills.
- The number of forest flora at 206 species, with 118 Tree species, 50 Shrub species and 38 herb species. Extent of Trees Outside Forests (TOF) or Greenwash (GW) is1335 sq km.
- The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size is 25.34 million tons.
- Invasive species, homogenization for horticulture usage, altered land-uses, infrastructure, Dilution of legal safeguards, exploitation due to human dependence are some of the major drivers of forest loss in Goa.

Vulnerable Ecosystems (Cave,Islands and Plateaus)

- There is a significant lacuna in our understanding of the Speleobiology of Goa. The unique cave system in Goa has been poorly documented and investigated for biodiversity. As a result, scarce information is available about this vulnerable habitat. Thus, this ecosystem requires prioritized attention for documentation of the highly sensitive and unique cave fauna in Goa.
- Caves under natural and/or anthropogenic pressures must be identified and investigated on a priority basis.
- Goa also has marine, estuarine and riverine islands that hold insular biodiversity that has not received much attention from biologists, barring sporadic efforts. Therefore, such primary data concerning the faunal and floral diversity will have to be systematically documented.
- Islands such as Bat Island and Grande Island are reeling under unregulated tourism pressure and need regulatory interventions.
- Plateaus are an extensive eco-geographic region of Goa between the Western Ghats and Coastal Plains and are poorly explored for the faunal assemblages.
- Presently, plateaus in Goa are experiencing severe land use changes due to anthropogenic pressure such as construction.
- Plateau flora and fauna must be explored urgently to identify critical/priority sites for legal protection.

Suggested Actions/ Way Ahead

- The effort shall require partnering between Forest Department, Academia and Researchers to collate a secondary database on various floral and faunal taxa. Goa Forest Department has multiple documents such as Management Plans, Working Plans, Inventory etc. ideally, this data should be procured.
- The data available with various BMCs in the jurisdiction of forested talukas of Goa will be valuable and must be accessed and referred to as secondary information.
- The Goa University and its affiliated Research Centres /Colleges must be mandated to share relevant data.
- Gaps in information on (Trees Outside Forests) TOF must be filled by field visits and collation of secondary data if available.
- As for caves, islands, and plateaus, primary data will have to be generated through field visits of representative ecosystems on a sampling mode along a fixed timeline. However, this approach will miss the occurrence of endemic species and the element of seasonality.
- Specific components of long-term research with tangible deliverables should be embedded in the template of the present time-bound effort. The project proposal for the same should be discretely submitted to the GSBB or any other suitable agency for funding support.
- Requisite publicity be given to the whole effort to create awareness among the stakeholders.

Expected contributions from

- Public
  - The GSBSAP must be people centric and participatory and hence every effort must be made to invite people to contribute . Consultations must be a part of field work.
  - Updated records from all sources, Govt and People .
  - Cross cutting themes such as cultural linkages, anecdotes by village elders, local utility and relevance, quantitative and qualitative trends for gross retrospective estimation
  - Verifiable 'People's Dependence' statistics/data
  - Interest and curiosity from public are important, lest the efforts are not met with enthusiasm.

- Academia / Scientific Community / Others
  - Unless mandated by GSBB , data is difficult to come forth from academia for reasons of unpublished data, IPR etc. GSSB must explain the purpose and assure all contributors of requisite and appropriate credits in the final plan.
  - Forest department must allow access to Forests, Protected and otherwise for field work if any.
  - Expertise if sought by Leader with prior approval of MS GSBB must be compensated
  - Requisite funding support from GSBB may be decided and released in advance to enable immediate commencement of the work.

GSBB's role:

- The proposal for the same can be discretely submitted to the GSBB or any other competent authority for funding support. Wherever primary data is not available timeline may be reasonably extended.
- GSBB should facilitate lateral linkages with government departments including Forest Department identifying a Contact point for coordination and facilitation .
- Forest Dept., Panchayats , BMCs, Municipalities, Port Authority, Marine Police , and all such other statutory /Regulatory authorities must be alerted on this exercise to ease access and impediment free field work.
- Necessary resources be sanctioned along with field personnel and liasoning official from GSBB
- Team Leaders to be endowed with letter of identity and permission to conduct field work , specially in biodiversity rich restricted areas.
- More staff to be deputed in GSBB for PBR co-ordination at district level, liasioning wih industries, farmers and others who utilize bio-resources.
- There is also requirement of establishment of extended offices of GSBB in North and South district for better management.

Epidemiology, Biodiversity and aspects of zoonotic diseases and allied forest issues

Dr Utkarsh Betodkar & team

Baseline / Scenario / Current Status of Respective Sector in the State of Goa

- Surveillance of outbreak prone diseases is been carried out by Integrated Disease Surveillance Programme (IDSP) as well as NVBDCP under Directorate of Health Services to detect and respond to disease outbreaks quickly.
- Major diseases of Public health importance which are linked to Climate and environment: Malaria, Dengue, Chikungunya, KFD, Influenza including Covid-19, Leptospirosis, Acute diarrheal diseases etc.
- With increasing environmental temperatures and scarcity of potable water cases of Diarrheal disease will be on rise this is especially evident in late summer season. Also with high temperatures cases of heat stroke & exhaustion will rise.
- Air Pollution if not controlled will be a problem Goa will face which will increase burden of acute respiratory illnesses.
- Diseases directly or indirectly linked to open garbage.

Suggested Actions/ Way Ahead

- Inclusion of Sanitary/ Animal Waste with in the ambit of Common Bio Waste Treatment Facilities
- Study by interdepartmental committee for better convergence mechanism of similar actions by various depts. And agencies dealing with health related matters in biodiversity context. More awareness amongst stakeholders
- Activities as cited earlier shall be strengthened.

Expected contributions from

- Public
  - Conservation and safe use of potable water. Availability of safe & Potable water at all levels in community.
  - Segregation of waste and availability of disposal areas or pick up of garbage.
  - Disease based precautions for prevention of diseases.
- Academia / Scientific Community / Others (Mention if specific missed out)
  - Sharing of environment and climate based information with health services in order to plan and take neccesary interventions for disease prevention.

Planning Process including RP, ODP for biodiversity conservation with focus on urban planning

Arch. K. D. Sadhale & team

Baseline/ Scenario/ Current Status of Respective Sector in the State of Goa

Various aspects related to Biodiversity & sustainability in context of urban planning are identified below

- Fast urbanization since last half a century has caused change in landform by hill cutting, wetlands and paddy fields by earth filling, meddling with natural water bodies, disturbing the sand dunes vegetation, mangroves etc. has been done in the name of development causing great harm to biodiversity.
- Productivity of land, water bodies and other natural assets of the town have not been considered in the urban design process. Destruction of paddy fields, productive farms, natural vegetation, salt pans, mangroves and sand dunes has caused great harm to sustainability.
- . There are few schemes for subsidy for alternative energy systems like solar, biogas etc. but there are many more areas and systems by which sustainability can be encouraged by Govt., scientific and technological forums.
- PDAs, Municipality, GSUDA, PWD, Sewage Corporation, electricity, water supply are the various development agencies. Each one of them work as per their own plan and program without an integrated approach with environmental aspects.

Suggested Actions/ Way Ahead

- Focus areas to be identified for urban sector
- Legislative review of present status -Town development rules and programs should be eco-responsive, ODPs should follow norms of population density and zoning proportions. Coordination of different development agencies and programs need to be organized. Town development programs should be eco responsive. A no development green belt should be provided to avoid sprawl of unorganized growth.
- Urban Infrastructure projects with focus on eco-system - Footpaths to be made tree shaded comfortable and user-friendly in view of maximum pedestrianization . Vehicles fueled with clean renewable energy. Underground cable without jumble of wires in air to allow free growth of roadside trees . Solar lighting, re-use of waste water, safe and comfortable public passenger travel system . Health and recreation spots along the water bodies and in thick vegetation groves.
- Waste management, drainage with respect to surface and sub-surface water management
- Eco-system of water bodies and design guidelines for its development - Local natural water bodies to be protected from pollution of garbage and sewage. No-development belt should be provided around the water body with natural vegetation to protect the aquatic and riparian fauna. Wetlands should be left undisturbed with their natural flora and fauna. Detailed guidelines should be given to do minimum construction of banks if required, with no concretization method

Expected contributions from

Public

- Presently public can contribute toward action plan by their suggestions about various ways people can act practically for slowing down the climate change and mitigate its ill effects through the public action and institutional support from the Government.
- We can reach out the public in the following ways: Through social media, leaflets, contacting various social clubs, environmental groups educational institutes, wildlife groups village BMCs, health groups etc.
- Expectations from general public: Public is the main stakeholder of the activities of slowing down the pace of climate change and mitigation of its hazards in a variety of practical ways like urban farming, activities like roof garden vertical garden, rain water harvesting, Solid waste segregation, home composting, re-use and re-cycle and reducing consumption, solar and renewable local energy options

Mammals and Associated Species

Dr. Nitin Sawant & team

Baseline/ Scenario/ Current Status of Respective Sector in the State of Goa

- In Goa, a total of 83 species of mammals are reported by Srikanth Jadhav and Samir Kumar Pati of ZSI in 2012.
- Slender Loris locally named as Van manus which resides in thick, thorny bushes and bamboo clumps is facing threat to its habitat due to deforestation and poaching.
- Various threats posed to marine mammals such as bottlenose dolphins due to expansion of the port and development of a large coal shipping hub (meant to bring in as much as 50 million tonnes of coal over the next decade).
- There are cases of human-animal conflict in some areas, for example, conflict with tiger in sural village.
- Atul Sinai Borker, with help from Mhadei Research Center(MRC) and Goa Forest Department has published a booklet on 25 small mammals.

Suggested Actions/ Way Ahead

- Strategies towards better planning and conserving critical habitats.
- Declaring new Biodiversity areas and assessing the existing BIAs
- Documentation of diversity and distribution of animals
- To inculcate interest among students towards scientific research
- Setting up specificresearch laboratories
- Preparing an annual report on status of BIAs
- Provision of grants (Major/Minor) for scientific research

Expected contributions from

Public

- Active participation in providing information
- Assessment of Man-Animal conflict through local interviews from local communities and forest department.
- Providing TK pertaining to specific species or habitat
- Community base conservation
- Providing local support for surveys and investigations
- Providing information regarding existence of biodiversity (Mammalian diversity)
- Critically assessing the habitat
- Awareness among masses through community involvement

Herpetofauna and Associated species

Dr Nitin Sawant & team

Baseline/ Scenario/ Current Status of Respective Sector in the State of Goa

- A total of 34 species of Amphibians have been reported from State of Goa.
- 2 species (Pedostibes tuberculosus, and Uperodon mormorata) are listed as Endangered, 1 Near Threatened (Clinotarsus curtipes), 1 Critically Endangered (Pseudophilautus amboli) and 2 species are listed as Vulnerable (Raorchestes bombayensis, Nyctibatrachus humayuni) under the IUCN Red List of threatened species.
- A total of 40 species of reptiles are reported from state of Goa.
- Hemiphyllodactylus goaensis and Fejervarya Goemchii are two new species which are added to herpetofaunal diversity of Goa
- The number of Amphibians and Reptiles from the state of Goa are increasing day by day upon new discoveries and new presence reports
- “Herpetofauna of Goa, Maharashtra and Karnataka” by Dr. Nitin Sawant is one of the ongoing project to asses the herpetofaunal diversity of Goa and neighboring states

Suggested Actions/ Way Ahead

- Documenting the existing herpetofauna within our political boundaries
- Assessing the existing IBBA's.
- Assessing the need to declare new IBBA's for conservation of habitats pertaining to critical species.
- To inculcate interest among students towards scientific research by giving them exposure towards the same.
- Setting up specific research facilities within Goa.
- Preparing an annual report on status of the protected habitats.
- Special attention towards conserving crucial habitats to conserve habitat specific species.
- Provision of grants (Major/Minor) for scientific research for encouraging research on biodiversity.

Expected contributions from

Public

- Active participation in providing information
- Providing TK pertaining to specific species or habitat
- Providing local support for surveys and investigations
- Providing information regarding existence of biodiversity (Herpetofauna)
- Maintaining the siting records/details

Marine/ Fresh Water Fish and other Biodiversity

Dr Baban Ingole, Dr Chandrashekhar Rivonker & team

Baseline/ Current Status of Sector in the State of Goa

- Mandovi and Zuari riverine systems together occupy about 2557 sq kms (70%) of the geographic area of the state. The unique feature of these systems is the euryhaline habitats formed due to both the tidal and the rain fed fresh water and support a diverse flora and fauna.
- Specialized niches include rocky shore (cliff, tide pools, boulder, platform, crevices),sandy and muddy shores. These diverse habitats promote variety of biota such as caprelidae, sea slugs, pycnogonida, hydrozoans, bryozoans, molluscs, sea urchins,holothurians and polychaete worms.
- A total of 96 species of phytoplankton belonging to diatoms, dinoflagellates and blue green algae have been recorded from estuaries and coastal waters of Goa.
- There are 224 species of fishes recorded from Goa coast
- Anthropogenic changes due to altered land use pattern in the coastal belt of the State has been a major cause of concern in view of biodiversity loss. This is further being synergized by the natural threat from climate change.
- In view of the above, it is pertinent that we initiate a continuous monitoring program to establish an inventory of localized diversity from aquatic habitats of Goa.

Table 5. List of protected marine species under Wild Life Protection Act 1972, India

Faunal group	No. of species	Schedule
Porifera	10	Schedule III
Coelenterata	618	Schedule I
Robber crab	1	Schedule I
Horseshoe crab	2	Schedule IV
Gastropodas	20	Schedule I, IV
Bivalvia	4	Schedule I, IV
Sea cucumber	163	Schedule I
Sharks and Rays	10	Schedule I
Seahorse	23	Schedule I
Giant grouper	1	Schedule I
Marine Turtles	5	Schedule I
Salt water crocodile	1	Schedule I
Marine Mammals	26	Schedule I,II

Source: ENVIS Wild Life Institute of India, 2014

Suggested Actions/ Way Ahead

- Create baseline inventory
- Digitise coastal habitat characteristics
- Manpower development to monitor coastal habitats and create baseline documentation of aquatic life.
- Photo-documentation of identified species.
- Mapping of coastal habitats through GIS technique.
- Anthropogenic activities (tourism, Coastal developmental activities) – Habitat degradation and diversity loss.
- Biodiversity records – role in conservation and restoration
- Identify indigenous species and communities

Expected contributions from

- Public:
  - Public participation is expected in the form of PBR as well as individual contribution

- Academia / Scientific Community / Others (Mention if specific missed out)
  - Various academic and scientific institutions present in the state can contribute to this efforts as they will have authenticated information and data on the biodiversity records and their possible uses/utility.

Traditional Knowledge/ Wisdom associated with Biodiversity, Sacred Groves etc.

Shri. Rajendra Kerkar & team

Baseline/ Scenario/ Current Status of Respective Sector in the State of Goa

- Lack of proper impetus for the traditional knowledge, have been noticed to be responsible for weakening the ties with it.
- There is need to highlight importance of the traditional knowledge in the fast changing scenario, at the earliest.
- Urgent need is there to plan the strategy to record and revive the traditional knowledge and practices.

Suggested Actions/ Way Ahead

- Identifying traditional knowledge holders through PBR, in the fields of ethnobotany, cuisine, folklore etc. related with environment and ecology.
- Providing them recognition from Goa State Biodiversity Board after scrutinizing the contribution is the need of the hour.
- Empowering the traditional knowledge holders by connecting them with the market in holistic ways.
- Creating the awareness regarding the traditional knowledge role and importance through the school and college, self help groups and clubs and other non government agencies.
- Involving the participation of public in tapping the traditional knowledge available in the area.
- Wherever possible locals should be allowed to take the benefits of minor forest produce strictly adhering the taboos.

Expected contributions from

- Public
  - Identifying and notifying the sacred groves as the community conserved areas along with providing necessary protection to the springs and water bodies.
  - Reporting of traditional varieties.
- Academia / Scientific Community / Others (Mention if specific missed out)
  - Scientific community should support in creating elaborate records of traditional knowledge and traditional varieties and validating these records.
  - Historians and archaeologists needs to be involved to draw connections between current practices and practices in the past. They could also conduct study on the ecological set up in the past and help to establish presence of certain species based on the past setup, for example, presence of tigers in an area based on Wagran temple.

Wetlands and Waterbodies

Dr Pradip Sarmokadam & team

Status of Wetlands and water bodies in the State of Goa

Wetlands:

In total 42 wetlands have been identified in the State of Goa
From which seven (07) Wetlands have been notified and 04 draft notified under Wetland (Conservation and Management) Rules 2017, in the State of Goa.
Further identification of wetlands is still under progress.

Waterbodies including (Wetlands):

As given in table, based on the data from National Wetland Atlas of Goa

Sr. No	Type	No.
	Inland Wetlands - Natural	
1	Ponds/Lakes	20
	Inland Wetlands-Man-made	
1	Reservoirs	2
2	Tanks/Ponds	62
3	Waterlogged/ Salt pans	7
	Wetlands (<2.25 ha), mainly Tanks	167
	Coastal Wetlands - Natural	
1	Mangroves	111
	Coastal Wetlands - Man-made	
2	Salt pans	70
	Total	439

	Goals	Strategy	Action
1.	Wetlands Conservation	Achieve 100% protection of identified wetlands	Notify all the identified wetlands under Wetland (C&M) Plan 2017, that are not protected under any other act. Identify and enlist all the wetlands that are protected under other relevant acts and ensure the compliance for concerned Authorities
2.	Wetlands Management& Monitoring	Health Card and Biological monitoring studies have to be carried out in wetlands (coastal inland and upland) and waterbodies.	Health Card and Biological monitoring studies have to be carried out in wetlands (coastal inland and upland) and waterbodies. Regular water quality analysis through empanelled agency of GSPCB
		Preparation of Integrated Management Plan (IMP) for wise use of ecosystem services of Wetlands for livelihood opportunities and incorporate in District Environment Plan and ensureimplementation	Site specific IMP for each notified wetlands that will ensure wise use of ecosystem services of Wetlands for livelihood opportunities and incorporate in District Environment Plan andensure implementation Revival of lost traditional uses of wetlands e .g. use of Khazan lands for cultivation of paddy (Korgut), including capacity of relevant stakeholders to sustainably manage fisheries and aquaculture, and ensure equitable sharing of benefits.
		Restoration of degraded wetlands and water bodies through involvement of locals to raise the sense of belonging	Take up public driven restoration of Wetlands thorough traditional practices and green skilling, and prevent the introduction of freshwater invasive species and control their spread
3.	Ensuring Protection	Wetland Biodiversity Protection	Biodiversity considerations shall be included in the policy, legal, and regulatory frameworks of WRD, Fisheries, Agriculture and animal husbandry to ensure conservation of fish and other aquatic organisms, and equitable sharing of benefits
		Wetland Ecosystem Protection	Changes in Regional Plan to be incorporated in order to ensure protection of wetland area
4.	Wetland of International Importance and priority Wetlands (wetlands of Local Importance)	Ensuring Ramsar Status to Nanda Lake as identified as wetland of international importance.	Including “Project on Improvement of Water Amount and Quality of Ramsar Sites (Wetlands of International Importance) and Priority Wetlands”.
5.	Wetlands for Climate Change mitigation andadaptation	Strategies utilisation of Wetlands for Climate change resilience and mitigation measures through increased carbon storage potential contributing to net emission targets and SDGs	Identification, protection and restoration of fallow Paddy fields (barren and uncultivated) and swamps habitats as artificial wetlands that serve the functions of wetland and its ecosystem services for climate change mitigation

Peoples Contribution

1. Wetland watch (Citizen science) and Wetland Mitra to record different wetland and wetland dependent biodiversity such as avifauna, fish, animals etc.
2. Waterbody restoration efforts through green skilling and traditional methods

Expectation of General Public

1. Sustainable use of wetland resources such as fish harvesting, Crop cultivation and harvesting, etc.
2. Avoid littering and dumping of garbage and plastics near/inside waterbodies

Livestock Biodiversity

Director AHVS & Team

Current Status of Sector in the State of Goa

- The following indigenous breeds are officially notified by ICAR- NBAGR:
  - Shweta Kapila Cattle- Complete white colored cattle found in North Goa and South Goa districts of Goa State. White color extends from muzzle to tail switch including eyelashes and muzzle (whitish brown). Population size is approximately 22,000.
  - Agonda Pig (Gavthi Dukor) - Adapt to hot and humid climate; higher disease resistance and adoptability to stress. Gavthi Dukor means village pig. Agonda Goan Breed of the pig plays major role in the profitability of pig rearing.
- Lack of awareness is a major obstacle for identification and reporting of indigenous breeds.

Suggested Actions/ Way Ahead

- Improve the genetic potential of our indigenous germplasm to make it more utilizable and economically viable for livestock keepers.
- Identification and documentation of repeated phenotypic characteristics of different indigenous breeds of livestock and poultry to help document the lesser-known populations.
- A baseline study for Agonda Pig, Shweta Kapila, and other such breeds needs to be initiated.
- Guidelines could be prepared and released to be followed for Gaushalas to identify and segregate the differentindigenous cattle.
- A separate scheme for non-descript cattle could be considered.
- A separate farm for selective breeding and maintenance of Shweta Kapila called as nucleus farm could be established which would also serve as a distribution point to provide the farmers with the indigenous breeds.
- Awareness a major hurdle in conservation of the indigenous breeds. Dedicated awareness programmes need to be run by the State.

Expected contributions from

- Public
  - Farmers and locals could help in providing inputs regarding the notified indigenous breeds and other newer or lesser-known breeds of goa.
  - Veterinary and para-veterinary staff as well as retired veterinary personnel could help spread awareness among various identified sectors like farmers, Gaushalas, dairy societies etc.
  - Farmers and local people could hep co-operate in national breeding programs to aid in conservation of the indigenous breeds.
- Academia / Scientific Community / Others (Mention if specific missed out)
  - A team of various scientists, field veterinarians, professors and students from colleges could aid in awareness programmes and identification exercises for the status assessment of the various breeds.

Communication, Information, Awareness, Capacity Building

Shri. Sagar Jawdekar, Shri. Prakash Kamat & team

Current Status of the Sector

- An organised plan is urgently needed to mobilise different state departments in helping sensitise the general public, particularly students, and mediapersons about biodiversity and conservation.
- Media organisations in Goa and individual journalists need to be provided incentive so that dedicated journalists are allotted to covering biodiversity and environment related subjects.
- Coverage of biodiversity conservation and environmental issues in media is scattered, superficial and even misinformed in many cases at present.
- Journalism courses in Goa colleges and even general colleges have no modules on environment, biodiversity and climate change to initiate students into this area.
- There is a need for capacity building of the line departments to understand that biodiversity conservation is a legal requirement especially considering the Biological Diversity Act, 2002.
- There is a need to communicate and popularise good practices of the State to the general public.
- Activities like biodiversity walks, tree walks are not on offer in Goa at present to aid education and to engage the general public on environment and biodiversity related issues.

The Way Ahead

- For General Public
  - On the lines of DD Kosambi Festival of Ideas, a series of prestigious annual lectures for the general public can be launched focusing only on biodiversity, environment and climate change. Prestigious invitees from all over the country and the world could explain their best practices.
  - Tree walks, bird walks organized every Sunday morning in different parts of Goa on a regular basis could help engage the general public on a regular basis on biodiversity.
  - At the annual awards function for village Biodiversity Management Committees, the award winners should present their best practices.
  - Many schools have spare land area and they should be given an incentive to plant and help the trees grow within their premises.
  - Modules on environment, biodiversity and climate change to be offered in colleges should be kept open for interested persons from the general public to attend on a first-cum-first-serve registration basis. While students will get course credits, other citizens can be issued certificates.

The Way Ahead

- For Journalists
  - Making journalists part of the capacity building workshops conducted for personnel of the departments like PWD, WRD, IMD etc. on Environment, Biodiversity and Climate Change related subjects.
  - Peer learning visits for journalists in other states, especially neighbouring coastal states, should be organised for better and in-depth understanding of biodiversity and environmental issues.
  - Media organisations should be pushed through policies to encourage their journalists to carry out root cause analysis that will add value to the decision making by policy makers.
  - Representation of journalists at Conference of Parties and other such national and international events on environment, biodiversity and climate change should be funded annually on a merit basis.

- The State CSR Mechanism should include grooming, training and peer learning of journalists & BMCs through CSR.
- Inviting proposals by journalists for carrying out PhD in environment related subjects by GSBB and other such organizations, which will help in journalists being groomed in the area of environment and biodiversity conservation through the external incentive.
- Exchange programs of journalists with other states like Kerala, Maharashtra and Karnataka, which have similar climatic and biodiversity conditions. Such programs will help provide journalists exposure, as biodiversity and conservation of any one area does not stand is isolation.

For Students of Journalism

- Modules and credit based course on environment and biodiversity for journalist students. Such an initiative can ensure that budding journalists are groomed to cover environment and biodiversity related areas right at the outset.
- Can be organized once a year with the help of Goa Union of Journalist (GUJ) and Goa Photojournalists' Association.

Expected contributions from

Academia / Scientific Community / Others (Mention if specific missed out):

- Academicians must support in preparing and vetting the syllabus for target oriented modules for green journalism and environment an biodiversity conservation.
- Their involvement will also be required in the workshops conducted for journalists and in judging different environment related competitions from a scientific point of view.
- Experts will be required for carry out tree walks, bird walks and other field visits for general public, students and journalists.