Annexure-I

Project title: **Habitat Improvement and Conservation Breeding of the Great Indian Bustard: An Integrated Approach**

Implementation agencies:
(1) Wildlife Institute of India
(2) Forest Departments – Rajasthan, Gujarat, Maharashtra

Collaborating agencies:
(1) Bombay Natural History Society
(2) The Corbett Foundation
(3) World Wide Fund for Nature

Budget: Rs. 33.85 crores

Timeline: September 2015 – December 2020

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

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1. Project background

Great Indian Bustard *Ardeotis nigriceps* (henceforth GIB) is one of the rarest birds in the world. With ~200 individuals left, almost exclusively in India, the species is listed as Critically Endangered (IUCN 2011) and Schedule I (the highest protection status, Wildlife (Protection) Act, 1972). Their populations have steadily declined by 75% in last 30 years and are facing imminent extinction risk unless serious management interventions are applied (Dutta et al. 2011). Historically, GIB was distributed throughout the western half of India, but, currently they are found in five fragmented pockets. According to our recent population assessment (Dutta et al. 2015), the largest population of 169±70 birds occurs in Thar landscape of Rajasthan (Desert National Park in Jaisalmer alongside Jodhpur). The other populations are <15 birds each, occurring in Gujarat (Lala-Naliya Sanctuary and its neighbourhood in Kachchh), Maharashtra (Bustard Sanctuary in Solapur, alongside Chandrapur and Nagpur), Andhra Pradesh (Rollapadu Sanctuary and its neighbourhood in Kurnool) and Karnataka (Bellary) (Dutta et al. 2011).

Research shows that GIB is an omnivorous bird primarily feeding on insects, fruits, and harvested crops. They live in dry, open landscapes comprising short grasslands, open scrub, and rain-fed agriculture. They are traditional to their breeding grounds, where, males display in open, well-grazed grasslands to attract females who prefer moderately tall and less-grazed grassland for nesting. Thus, a mosaic of short and tall vegetation with little disturbance is ideal for breeding. Their non-breeding usage is vast and distributed across well-connected, productive areas with short fruiting shrubs and fallow fields. However, their seasonal movement patterns and critical resource requirements for nesting, chick-rearing and lekking are complex and poorly understood. Existing research on GIB and related species shows that large heterogeneous agro-grassland patches have highest conservation value (del Hoyo et al. 1996). Although these birds are intolerant to intensive development, they are compatible with traditional, low-intensity land uses that can create some win-win conservation situations (Dutta and Jhala 2014).

The species has declined due to compounding effects of direct and indirect human exploitations on their slow life-history traits. They were subjected to exhaustive hunting and egg collection in the past that reduced their population to ~1260 birds in 1969 (Dharmakumarsinhji 1971). They are still hunted in Pakistan where birds from India perhaps migrate seasonally, and also in Thar, Rajasthan. However, their contemporary decline is largely due to prevailing habitat loss as dry grasslands have been marginalized as 'unproductive wastelands' and progressively converted to other land uses since colonial times. Recent developments in irrigation and farming technologies have intensified agriculture in bustard habitats and changed cropping practices from seasonal to year-round, intensive crops. This has led to food scarcity, pesticide contamination, and habitat loss. Development activities like mining, industries, power projects, wind turbines, and associated infrastructure growth (buildings, electricity and road networks) have caused severe habitat degradation and disturbance to birds. Being low and heavy flyers, they face a high risk of fatal collisions with power-lines that are difficult to detect from afar. Feral dog populations have increased in their habitats, and along with native predators (fox, mongooses, and cats), they have increased predation pressure on nests and chicks and reduced recruitment. Past efforts of banning human activities to create bustard Sanctuaries over large human-use landscapes, without appropriate settlement

of land rights, have generated bitterness among local people, lack of conservation support, and backlash. These factors have in turn to local extinctions from some Sanctuaries. Local people and managers are not sufficiently aware of the conservation benefits of grasslands and the scientific ways to manage them. While, the traditional ways to manage these habitats are eroding due to rapid socio-ecological changes driven by state policies (Dutta et al. 2013). Although most remaining breeding habitats are protected to some level, the vast movements of bustards expose them to the threats mentioned above in the non-breeding habitats, defeating the purpose of protecting small breeding reserves. Since these large bustard landscapes cannot be freed from human uses, a mixed approach of Protected Area based conservation of breeding habitats and coexistence with compatible human land uses in adjoining landscapes best suits the situation. Effective conservation of these landscapes would require information on species' ranging patterns, relative magnitudes and distribution of threats, and ways to reconcile the species' ecological needs and livelihood concerns that are poorly known. Furthermore, management authorities in many areas exhibit poor enforcement ability due to inadequate staff and infrastructure, lack of motivation, and inaccessibility.

Concerned about the extinction crisis of GIB, Indian conservation circles have proposed the Government to adopt strategic recovery plans for the species as a flagship of dry grasslands. In light of these issues, the National Guidelines for Bustard Recovery Plans (Dutta et al. 2013) strongly recommend filling research gaps, improving habitat, improving enforcement capacity, and engaging communities in conservation. However, the implementation of in-situ conservation measures require some gestation time, but, the population size of GIB (with no birds in captivity) is too small to sustain such delays. Thus, a captive population needs to be secured for supplementing wild populations and reintroducing birds into restored habitats in favorable times.

We propose an overarching project that integrates all these components into a holistic conservation plan for the priority bustard landscapes of Rajasthan, Gujarat, and Maharashtra. The proposed activities will be undertaken in collaboration with State Governments, local NGOs, and research organizations so as to pool knowledge/expertise and ensure timely and effective implementation. Since both the endangered bustards of dry grasslands – great Indian bustard and lesser florican – share habitats, these activities will supplement and complement each other's needs. In doing so, habitats that support a plethora of other endangered wildlife, such as the spiny-tailed lizard *Saara hardwickii*, chinkara *Gazella bennettii* and foxes *Vulpes* spp, will be restored.

2. Goals and objectives

The broad goals and objectives of this project are as follows:

- **Conservation Breeding**

Developing and running Conservation Breeding Center to secure captive populations of great Indian bustard and (if needed) lesser florican as insurance against extinction and (if possible) subsequent reintroduction into restored habitats

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- **Applied research**

Undertaking targeted research for:

a) prioritizing conservation areas, b) characterizing threats, c) monitoring populations and habitats to assess the effectiveness of management actions, d) assessing local communities' livelihood concerns and willingness to adopt bustard-friendly land uses, and e) comprehensive understanding of population genetics to inform conservation management

- **Capacity-building and awareness**

a) Improving protection enforcement through training of Forest staff and implementation of technology aided patrolling , b) sensitizing decision-makers, managers and local communities on bustard conservation, c) raising public awareness and support for bustard conservation through awareness materials, and d) incentivizing local land users to adopt bustard-friendly land uses

- **Pilot implementations for surgical habitat management**

Demonstrating best practices for habitat improvement through pilot/experimental surgical interventions that will be subsequently replicated by State Forest Departments

3. Scope of work

Conservation breeding

The Ministry of Environment, Forests and Climate Change (henceforth MoEFCC) has decided to commence a national Conservation Breeding Programme for GIB to secure an insurance population. These captive birds can be reintroduced into restored habitats if conditions are favorable in future. This program will involve State Governments of Rajasthan, Gujarat and Maharashtra as the main partners, and will be supervised by the Wildlife Institute of India. The National CAMPA funds will be utilized in setting up the infrastructure for this Captive Breeding Facility in the first four years, running it for 25-30 years, and subsequently releasing and monitoring the birds between 30-35 years. The roadmap for this activity has been broadly outlined through consultative workshops, but a detailed program plan has to be developed through collaboration with expert agencies or personnel in the first two years of the project. Given the critically endangered status of the species, this program should not be treated as a trial but a fully fledged activity with cutting-edge infrastructure and expertise. For smooth functioning, sustained financial support, respective roles/responsibilities, and cooperation between the stakeholders, a project document or memorandum of understanding needs to be formulated in consensus with partner agencies.

Applied research

Existing/potential bustard habitats have to be identified for conservation management and objectively monitored to assess management effectiveness. This entails developing and implementing systematic and scientific surveys across the ranges of great Indian bustard and lesser florican to generate baseline information on their population parameters and monitor their changes over space and time.

Bustards undertake wide movements across large landscapes that cannot be entirely conserved. Although birds are protected within small breeding reserves, they are exposed to various emerging threats during such movements in unprotected landscapes. Bustard conservation will only be successful if these threats are mitigated at the landscape-level. This requires information on ranging patterns of many birds from different landscapes so that intensively used areas, and connectivity corridors/flyways can be identified and prioritized for conservation investment and minimization of development. The advent of satellite telemetry has opened up a new horizon for remotely monitoring movement patterns of such wide-ranging species. Such information can be analyzed to prioritize development vs. restrictive-use zones.

In addition to understanding bird movements, spatial distributions of multiple threats and their relative impacts on bustard need to be characterized for effectively mitigating threats at landscape-scale. Therefore, research aimed at mapping of power-line networks, pesticide-prevalence, and dog densities are required across landscapes.

Finally, there is a need to understand the genetics of bustard populations to manage them effectively. A study based on mitochondrial DNA suggested very low genetic diversity and effective population size and indicated no phylogeographic structure of great Indian bustard females across the country (Ishtiaq et al. 2011). These inferences need to be strengthened with further evidence based on nuclear microsatellite markers. Nuclear microsatellite markers provide information on both genders, and since they have a higher mutation rate when compared to mitochondrial DNA, they can reflect recent demographic events of conservation importance. Thus, a combination of mitochondrial and nuclear marker-based approaches will provide holistic inferences on processes affecting bustard populations that cut across demographic classes and time scales. These combined inferences entail a comprehensive understanding of a) whether populations are disconnected or continue to exchange individuals; b) the rate and direction of such genetic exchange and how that is influenced by distance, demography and anthropogenic factors; c) the degree and timing of genetic bottlenecks and other demographic events experienced by the remaining populations; d) the ecological/geological processes that have shaped the past and present genetic structure/composition; and e) how to conserve the present genetic diversity in wild and captive populations. Understanding these aspects have strong implications on both in-situ and ex-situ management. The rarity and sparse distribution of GIB preclude precise population assessment through observation-based approaches (discussed in Dutta et al. 2015). Therefore, another potential and important application of genetics would be to integrate molecular identification of individuals with spatial capture-recapture models to obtain precise estimates of local (small-scale) population abundances. However, some of the above questions might be difficult to answer at this moment considering the rarity of bustards that constraints collection of adequate genetic samples and the unavailability of historical samples.

Capacity-building and awareness

a) To strengthen protection measures across large GIB landscapes, patrolling ability of Forest Department needs to be improved by recruiting an adequate number of trained forest guards. It has been

noted that frontline staff in GIB landscapes have very low motivation and capacity to enforce law partly because of the harsh and remote field conditions of these areas. Their performance needs to be significantly enhanced by providing better incentives, appropriate training, necessary infrastructure and equipment, and establishing information and vigilance networks through regular communication with local people.

b) Bustards share their habitats with multiple stakeholders: local communities who depend on these habitats for subsistence; forest department that is empowered to protect these habitats; government officers from revenue, agriculture, animal husbandry, dairy and power departments whose agendas might be in conflict with the interest of bustard conservation; and private industrialists whose activities might be degrading these habitats. The key stakeholders in each of the bustard landscape have to be identified and sensitized through meetings and workshops to make them aware of the ecological hazards of unplanned development in grasslands.

c) Local people depending on bustard habitats for subsistence needs have to be encouraged to opt for agro-environmental schemes that incentivize bustard-friendly practices to balance conservation and livelihoods. Some bustard-friendly land uses are organic farming of seasonal food crops, reducing cropping frequency and stall-feeding livestock during monsoon. National CAMPA funds can be utilized to initiate pilot projects where households who have adopted these practices are compensated for the foregone production cost. Such measures have resulted in a dramatic revival of little bustard population in Europe (Bretagnolle et al. 2011). To enable this course of community-based conservation, workshops have to be conducted in select villages within priority conservation areas. Effects of the above activities on bustard population and threat parameters need to be monitored so that policy-makers and managers can replicate the effective ones at larger scales. These activities have immense potential in sustaining green development and reducing our carbon footprint.

d) It has also been noted that general public have poor awareness of bustard and grassland conservation. Publicity materials such as posters, boards, and short movies need to be developed in collaboration with experts to raise general awareness of these issues.

Pilot implementations of surgical habitat management

a) Bustard breeding areas are public-private mixed ownership lands not entirely controlled by Forest Department, which makes it difficult to implement protective measures. There is a need to acquire revenue lands and some private lands to consolidate contiguous breeding areas and critical non-breeding areas. For instance, some small grassland patches within agricultural matrix might allow the birds to persist and needs to be protected from land use conversion in future. To facilitate this process, strategically located lands have to be identified and acquired by Forest Department utilizing State CAMPA funds. This activity can be viewed as compensatory land acquisition for industrial activities under the Forest (Conservation) Act, 1980. In some parks, rationalization of the boundary is also required in light of new information on species' distributions and persistent resentment or growing antagonism of local people.

b) Only 4-5 GIB breeding sites are left that are of critical importance to the species' survival, but do not contribute significantly to the persistence of other species. These sites need to be secured by legal status and total ban of consumptive human activities (excluding authorized management, protection, and research) during the breeding months: June-October. Enclosures that restrict livestock and nest predators need to be erected before the next breeding season. All mammalian predators (dogs, pigs, jackals, foxes, cats, and mongooses) need to be removed from these enclosures to reduce predation of GIB nests/chicks and improve recruitment. To restrict GIB inside enclosures during the vulnerable breeding phase, thereby minimizing human disturbances and improving recruitment rates, GIB food plants can be grown in enclosures.

c) Overhead power lines have to be routed underground or marked prominently to minimize the risk of fatal bird collisions (Silva et al. 2014) in priority conservation areas. Wind turbines should also be discouraged in these areas as they increase power-line networks and disturbances. Scientific dog sterilization, removal, and subsequent monitoring program have to be undertaken in priority conservation areas. This will benefit not only GIB but also other desert fauna since feral dogs are a major threat to all wildlife through the spread of diseases and predation.

4. Approaches and methodologies

The following activities will be undertaken by the Wildlife Institute of India in collaboration with its partner NGOs and State Forest Departments in research identified areas within bustard landscapes.

Activity 1: Conservation Breeding

A conservation breeding facility would be developed by the Wildlife Institute of India in consultation/collaboration with international bustard breeding agencies. The founder captive population would be formed from wild-collected and artificially incubated eggs rather than adult birds. Eggs have very low survival probability in the wild, whereas, capturing of wild birds can jeopardize the fate of in-situ populations. Set of favorable conditions (relatively higher rainfall, lower temperature and proximity to source population) has to be ensured to maximize the growth of the captive population. Keeping this in mind, a site near Mandvi (Kachchh, Gujarat) has been selected for developing the main center. Additionally, a satellite center has to be developed near Jaisalmer (Rajasthan) which is the most potential area for egg collection. The satellite center will have a small incubator, hatchery, and a chick holding facility, with uninterrupted water and electric supply. The role of satellite center would be to hold eggs until sufficient numbers have been collected at one go (5-8 per year) that would be transported by road in temperature-regulated containers to the main center. The main center would be developed with incubation rooms, hatcheries, juvenile and adult bird holding and breeding facilities, food processing facility, staff quarters and office, with uninterrupted electricity and water supply. The main and satellite centers would be constructed by the Civil Construction Unit of MoEFCC, with which WII has a Memorandum of Understanding. Centers would be constructed after appropriate planning with bustard breeding experts and zoo architects. The center will be run by professionals (center manager,

veterinary officer and technical assistants) who are appropriately trained in international bustard breeding facilities, with the guidance of visiting bustard breeding expert(s). Additional funds will be acquired to sponsor the international training trips of these officers. A detailed action plan will be developed in consultation with the visiting bustard breeding expert(s) in the first two years of the project. The facility will be run till a self-sustaining founder population has been established, which might take 25-30 years. Subsequently, captive-bred birds will be released into the restored habitats of Gujarat, Maharashtra, and Rajasthan, following scientific release protocols between 30-35 years. This project entails the first implementation phase of the conservation breeding program, and the budget including the contracts and salaries of the center staff will be revised at the end of this phase.

Activity 2: Applied research

The following research activities are essential to guide where, how and what in-situ management measures should be implemented for judicious investment of conservation funds.

2a) Population and habitat surveys

Existing and potential bustard habitats will be identified for conservation management and their status will be monitored for objective assessment of management effectiveness. The project proposes population and habitat status evaluation surveys for both endangered bustards inhabiting semiarid grasslands - the GIB and lesser florican. Two-phase surveys will be conducted by the research team in collaboration with Forest Department frontline staff to generate baseline information (2016-17) and detect changes (2020-21). These surveys will generate spatially explicit information on species' occupancy and abundance along with habitat status. A survey protocol based on line transect distance sampling and occupancy analysis (Buckland et al. 2004, Mackenzie et al. 2006) has been developed by Dutta et al. (2015) that can be further refined to achieve replication across other landscapes.

2b) Ranging patterns using biotelemetry

Landscape use patterns of bustards will be studied by satellite telemetry on 6-12 GIB (2-4 each in Rajasthan, Gujarat, and Maharashtra landscapes) and 4-8 lesser florican for 4-5 years. Birds will be captured using foot noose and fitted with 70gm (GIB) and 5 gm (lesser florican) solar GPS PTTs for transmitting location information to remote computers. This data can be analyzed with remotely sensed and field collected ecological variables (e.g., land cover, disturbance, topography, and food) to understand space use patterns. This activity will provide crucial information on seasonal movements, critical resources, relationships with human disturbances and connectivity between landscapes.

2c) Assessment of threats and livelihood concerns

For judicious utilization of conservation funds to mitigate threats at landscape-level, research teams will characterize the spatial distribution of power-lines, pesticide-prevalence and dog-densities. Spatial risk maps will be generated from the overlapping distribution of birds and these threats (see activity 3c).

For reconciling resource dependency of local communities and conservation goals, research teams will conduct sociological surveys to assess stakeholders' dependency on bustard habitats and their

perceptions regarding bustard conservation (Marshall et al. 2010). Agro-pastoral households will be sensitized on ecological hazards of inorganic farming and livestock overgrazing through mobile workshops and documentary films in collaboration with partner NGOs (see activity 4b-2). Subsequently, the willingness of agro-pastoralists to adopt bustard-friendly practices will be assessed based on choice experiments. Combinations of financial incentives like compensation, resource supplementation, relocation and alternate livelihoods will be provided for pursuing organic farming, reduced cropping, stall-feeding of livestock during monsoon or reduced stock size (Harihar et al. 2015). We will also include local communities' knowledge in land use planning through Participatory Rural Appraisals (Chambers 1994).

2d) Conservation genetics

Great Indian bustard and lesser florican feces and feathers will be collected systematically across each landscape during population/habitat surveys, dried, stored in plastic bags with silica crystals, and transported to WII laboratory at the earliest. DNA will be extracted from these samples using modified Qiagen tissue kit or Guanidinium thiocyanate method (Boom et al. 1990). DNA will be amplified using Polymerase Chain Reaction (PCR), with mitochondrial DNA markers and nuclear microsatellite markers, which have been used in other endangered bustard species. Individual-level data, thus generated, will be analyzed to a) estimate abundances of local populations in a spatial capture-recapture framework (Efford and Fewster 2013, Moore and Vigilant 2014); b) assess migration rates and patterns (differences between genders, landscapes etc.) between landscapes using a full likelihood and bayesian coalescence based computation analysis of genetic partitioning (Beerli and Felsenstein 1999, Hey and Nielsen 2007); c) estimate population parameters, including diversity statistics (Excoffier et al. 2005) and effective population size, using a likelihood analysis with Metropolis algorithm using random coalescence based method (Kunher 2006); d) determine phylogeographic structure using a bayesian phylogenetic analysis (Drummond and Rambaut 2007); e) identify geological and ecological processes influencing phylogeographic structure using coalescence based analysis in an approximate bayesian computation framework (Cornuet et al. 2008, Lopes et al. 2009, Wegmann et al. 2010, Lopes and Beaumont 2010); f) characterize population bottlenecks using tests of mutation-drift equilibrium with allele frequency data or coalescence based models (Piry et al. 1999, Cornuet et al. 2008); and g) compare genetic composition of captive stock with respect to the wild population based on genetic diversities (Excoffier et al. 2005) and population structures (Pritchard et al. 2000, Corander et al. 2008).

Activity 3: Capacity building and awareness

3a) Improving management enforcement

To enable real-time monitoring of illicit activities across vast GIB landscapes, a technology aided patrolling framework will be developed and implemented through frontline staff of Forest Department in conjunction with local people on the lines of MSTrIPES (Jhala et al. 2011). This activity entails developing tools (equipment, software and platform) that can be used by patrolling teams to collect information on ecological (species and habitat status) and management (poaching, land use conversion

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etc.) parameters. These information will be collated in a central database that will generate statistics and maps on spatial and temporal trends of these parameters to guide management decisions spontaneously. Research teams will train frontline staff of each state on the application of this tool during routine activities. This tool can also be used for assessing staff performance and providing incentives so as to improve protection enforcement. Attempts will be made to sensitize local youth on bustard conservation through our partner NGOs with the formation of clubs such as 'Friends of Bustard'. Sensitized people can be eventually engaged in patrolling activity through appropriate training by our research team on technology aided patrolling. Additionally, we will explore the possibility of supplementing enforcement with the use of Unmanned Aerial Vehicles. These 'Conservation Drones' are relatively inexpensive (~1 lakh INR), can fly across 25 km for 50 minutes while taking high-resolution aerial photographs that can be analyzed to map land-cover, monitor illicit activities and birds, and have immense potential in ecological monitoring (Koh and Wich 2012).

3b) Stakeholder sensitization

1) Research teams will identify key stakeholders of bustard landscapes and initiate informal meetings with them. Representatives from various stakeholder groups (decision-making and implementing officers in public/private agencies and local community members) will be invited to participate in workshops where they will be sensitized on bustard conservation issues. One 2-day workshops will be organized in each State, once every year, with the capacity of 10-20 participants. Workshops will be conducted by subject experts and local figures, and will include 'reality check' visits to bustard habitats.

2) To promote bustard-friendly practices in priority conservation areas, mobile workshops will be conducted in select villages by the research team and expert resource persons. These workshops would sensitize local land-users and encourage them to support bustard conservation (see activity 2c).

3c) Raising public awareness and support

To raise general awareness on bustard conservation issues, we will involve expert consultants for developing and distributing: a) publicity posters in educational and marketplaces in/adjoining bustard habitats; b) publicity boards in prominent places in/adjoining bustard habitats; and c) promotional documentary film on the need, challenges and efforts for bustard conservation featuring national and local celebrities (actors, sportsperson and spiritual gurus). The film will be uploaded on social network and aired in television channels for wider outreach and advocacy.

Activity 4: Pilot implementations of surgical habitat management

4a) Strategic land acquisition/rationalization

Areas intensively used by GIB for breeding and critical non-breeding activities will be identified through population surveys and radio-telemetry (see activity 2a-b). The ownership and extent of these lands will be mapped from Revenue and Forest Department documents and ground validation surveys. Critical lands owned by Revenue Department will be proposed for transfer to Forest Department. In case of private/community-owned lands, research teams will sensitize target land-owners about GIB

conservation and assess their willingness to sell lands. State Forest Departments will be encouraged to utilize State CAMPA funds for purchasing these private lands. A multi-criteria decision framework incorporating this information will be used to prioritize lands for acquisition by Forest Department. Relatively large and contiguous unprotected lands, which have high conservation value but pose practical problems against acquisition, will be proposed for declaration as Community/Conservation Reserves (Section 31A of Wildlife (Protection) Amendment Act 2002 (2003). In the process, some areas within Sanctuary expanses might be identified as poor wildlife habitat, and would be rationalized to alleviate local people from the legal restrictions on subsistence activities. These processes have already been initiated in Thar, Kachchh and Solapur landscapes by various agencies and need to be concluded.

4b) Breeding enclosure management

Priority GIB breeding enclosures (e.g., Sam-Sudasari, Ramdeora and Lala-Naliya) would be selected for experimental management with the paramount objective of improving bustard breeding success:

1) A predator- and livestock- proof chain-link fence (6 feet above ground, angled outside with barbed wires, and 1 feet below ground) would be laid around enclosures, each covering >10sqkm area. The required funds will be transferred to the Civil Construction Unit or to the respective State Forest Departments for undertaking these construction activities. Research teams would subsequently monitor the effectiveness of the fence in preventing undesired species from trespassing using signs/camera-traps.

2) Research teams would assess the status of nest predators (e.g., foxes, mongooses, monitor lizards, wild pigs and dogs) inside enclosures using camera-traps. The potential impact of these predators on ground-nesting birds would be assessed using dummy nests accessorized with camera-traps. On a need-basis, these predators would be trapped and released in suitable habitat outside the enclosure following scientific protocols and appropriate permits.

3) Food plants of GIB like alfalfa/lucerne *Medicago sativa* and chickpeas /gram *Cicer arietinum* will be cultivated organically in a few plots not exceeding a total of 1 ha area to increase food resources for birds. This activity of growing food crops will be restricted to one portion of the enclosure and completed before the onset of breeding season to minimize disturbance. Their effectiveness would be monitored by comparing bustard usage of these locations with that of random locations. If these practices yield favorable results, then State CAMPA funds can be utilized to replicate them elsewhere.

4c) Mitigating critical threats

1) To mitigate the detrimental effects of power-lines, research teams will map the spatial risk of bustard collision with power-lines by integrating information on electricity network (activity 2d), ranging patterns (activity 2b), and intensity of habitat use (activity 2a) following Silva et al. (2014). Based on the risk map, we will prioritize power-lines for the following actions: making overhead power lines underground in high-risk areas and marking power-lines with Bird Diverters in moderate-risk areas.

2) Abundance and ranging patterns of dogs will be assessed using mark-resight method and GPS data-loggers to map the spatial risk of wildlife encounter with dogs (Matthews et al. 2008). Large-scale scientific dog sterilization programme would be undertaken in priority areas by involving expert

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agencies like the Corbett Foundation and Human Society International. The effectiveness of this action would be monitored in terms of dog population trends in subsequent years.

3) Pesticide prevalence in bustard food and physiology will be assessed following Tanabe et al. (1998) from spatially representative samples of GIB and lesser florican fecal/feather and food samples. Areas where agricultural use of pesticides has to be reduced will be identified from a spatial risk map generated by overlapping the distribution of birds and pesticide prevalence. State Forest Departments and allied agencies (e.g., State Pollution Board and Agricultural Department) will be encouraged to provide financial incentives (Agro-environmental Incentive Schemes) to farmers for opting for organic farming in these priority areas. To demonstrate the pros and cons of such investment, National CAMPA funds will be utilized for pilot implementation of these agro-environmental incentive schemes in a small area of few square kilometers within the priority bustard habitat of each State.

5. Outcomes

- **Activities related to conservation breeding** will result in:

1. A functional breeding center in 5 years; and
2. A self-sustaining captive population of bustard as insurance against extinction in future.

- **Activities related to applied research** will result in:

1. A standardized protocol to monitor population/habitat status and assess management effectiveness;
2. Prioritization of conservation areas within bustard landscapes for land use planning;
3. Spatial risk maps of critical threats for judicious allocation of mitigation measures;
4. Understanding of livelihood concerns and scope of implementing bustard-friendly land uses to identify mechanisms that can balance conservation and livelihood needs; and
5. Comprehensive understanding of the past and present genetic scenarios of bustard populations and their causal processes to identify factors limiting species' recovery.

- **Activities related to capacity building and awareness will result in:**

1. Intensification of protection enforcement and spontaneous management of threats;
2. Sensitization of stakeholders (decision-makers and local people) about bustard conservation;
3. Community engagement in conservation; and
3. Increased public awareness and support for bustard conservation.

- **Activities related to pilot implementations of surgical habitat management** will aid in:

1. Identifying strategic lands for acquisition and revision of Protected Area expanse for effective conservation enforcements;
2. Demonstrating best practices for managing breeding enclosures; and
3. Mitigating critical threats in priority bustard habitats, such as reduction of dog numbers, overhead unmarked power lines and pesticide prevalence.

Log-frame

Goal	Action	Approach	Prerequisites / Assumptions	Output	Implementation time	Monitoring Indicators	Risks
Securing a captive population as insurance against extinction	Conservation breeding	Collection of wild eggs from Rajasthan; artificial incubation of eggs, rearing of chicks & adult birds to form a captive breeding population of GIB & (if needed) lesser florican in Gujarat	Mutual agreement & cooperation between partners (State Governments of Gujarat & Rajasthan & MoEFFCC); permits of egg collection & construction of breeding centers	Functional captive breeding facility	1-5 years	Laying & construction of basic facilities in 2 years	Obstacles in agreement & cooperation between partners, unavailability of wild eggs due to poor rainfall & other stochastic events that can reduce production in captivity
						Initiation of artificial incubation on 3rd year	
						Addition of birds in captivity from artificially incubated eggs on 5th year	
				Development of captive breeding population	10-25 years *	Initiation of reproduction in captivity on 15th year	
					25-30 years *	Formation of founder population in captivity on 30th year	
				Reintroduction of captive birds	30-35 years *	Initiation of site selection & reintroduction	
Recovery of wild population & improvement of habitats	Applied research	Satellite telemetry	Permits related to tagging of birds & import/use of telemetry equipment	Prioritization of conservation areas	1-5 years	Tagging of 3 GIB by 2nd year & 6 GIB by 3rd year	Delay in permits & loss of tags
						Satellite data acquisition of >1 year by 4th year	
						Report on spatial prioritization on 5th year	
		Population/habitat surveys - line transect & habitat plots	Research permits, cooperation & infrastructure of State Forest Department	Baseline estimates of population & habitat status	1-5 years	Status survey reports on 2nd year	Inadequate statistical power to detect population trends due to rarity of birds
				Preliminary assessment of management effectiveness	1-5 years	Status survey report on 5th year	
		Characterization of threats to guide threat mitigation	Coarse-scale understanding of bustard occupied areas	Threat maps (power-lines, pesticides & dogs)	1-5 years	Threat assessment report on 5th year	Future shifts in distribution of threats
		Social surveys & appraisals	Coarse-scale understanding of bustard occupied areas	Understanding of local communities' resource dependency, conservation attitude & willingness to adopt sustainable landuses	2-4 years	Social survey reports on 4th year	
	Pilot surgical habitat management	Breeding enclosure management (fencing, predator-removal & food provision)	Cooperation & facilitation of management actions by Forest Department	Demonstration of best-practices for managing breeding enclosures	1-3 years	Improved recruitment rate of birds based on dummy nest experiments on 3rd year	Lapse in motivation & non-sustenance of practices beyond project period
		Mitigating critical threats in priority areas	Fine-scale information on priority bustard habitats & cooperation of relevant agencies	Marking of power-lines & population control of dogs in priority bustard habitats	1-5 years	Reduction of threats in priority bustard habitats based on reports before (2nd year) & after (5th year) the implementation	Lack of support from power corporations & local people
		Surveys to identify lands for strategic acquisition & rationalization	Fine-scale information on priority bustard habitats	Revision of Protected Area expanse to improve management & reduce antagonism	2-4 years	Report on land identification for acquisition/rationalization on 4th year	Lapse in Government will & inadequate funds to acquire lands
Stakeholder engagement in	Capacity-building &	Implementation of technology aided	Logistic support & facilitation of Forest	Regular & systematic collation of ecological/	1-3 years	Patrolling information database & reduced time-lag in management interventions on 3rd year	Lapse in motivation & non-sustenance of

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Goal	Action	Approach	Prerequisites/ Assumptions	Outputs	Implementation Time	Monitoring Indicators & Time	Risks
conservation	awareness	patrolling through technology & incentives	Department for implementing program	management information to guide management			activity beyond project period
		Workshops to train forest officers	Formulation of coursework & publication materials in collaboration with experts	Improvement of management skills	1-5 years	Officer training assessment reports every year	Non-cooperation of Forest Departments
		Workshops to sensitize non-forest officers		Sensitization of decision-makers & to plan landuses as if conservation matters	1-5 years	Positive conservation attitude of officers based on feedback reports every year	Non-cooperation of other departments & agencies
		Mobile workshops to sensitize local people		This activity will promote conservation support & sustainable landuses	1-5 years	Positive change in conservation attitude of local communities based on social surveys before (2nd year) & after (5th year) workshops	
		Production & distribution of publicity materials		Public awareness about bustards & their conservation significance	2-4 years	Positive change in knowledge about bustards based on social surveys before (2nd year) & after (4th year) publicity campaigns	
	Promoting bustard-friendly landuses	Pilot implementation of compensation schemes to incentivize bustard-friendly landuses in priority conservation areas	Fine-scale information on priority bustard habitats	Increased crop-area under organic farming & reduction in livestock grazing during breeding season in pilot implementation areas	3-5 years	Reduction in pesticide usage & increase in herbaceous cover in implementation areas on 5th year	Lapse in liaising & funding support for replicating this activity beyond project period & other priority areas

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Budget (Amount in Lakhs INR)

Head	Particulars	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
Staff engagement	3 Project Scientists (1 CBC + 1 vet + 1 field)	20.16	22.18	24.39	26.83	29.52	123.08
	2 Project Associates (field)	10.85	11.93	13.13	14.44	15.88	66.23
	4 Project Assistant grade 2 (2 CBC + 2 field)	9.60	10.56	11.62	12.78	14.06	58.61
	4 Project Assistant grade 1 (1 CBC + 3 field)	7.30	8.03	8.83	9.71	10.68	44.54
	8 Field assistant grade 2 (5 CBC + 3 field)	10.08	11.09	12.20	13.42	14.76	61.54
	3 Field assistant grade 1 (field)	2.88	3.17	3.48	3.83	4.22	17.58
	Daily labour in field & CBC	3.06	3.37	3.70	4.07	4.48	18.68
	Project Management Unit (part cost)	15.36	13.65	14.80	16.05	17.43	77.29
	Total costs of staff engagement	79.28	83.96	92.15	101.14	111.02	467.55
Conservation Breeding	Center establishment costs	414.00	270.00	225.00	90.00	90.00	1089.00
	Center running costs	14.85	39.85	41.84	41.84	43.84	182.22
	Center maintenance costs	0.00	0.00	4.50	22.50	22.50	49.50
	Miscellaneous costs (training, collaboration & contingency)	47.44	36.49	18.82	15.07	15.52	133.34
	Total costs of conservation breeding	476.29	346.34	290.16	169.41	171.85	1454.06
Applied research	Satellite telemetry costs (PTT & trapping costs)	33.34	52.09	16.05	14.85	15.53	131.86
	Threat assessment surveys (vehicle charges)	13.50	13.50	14.85	14.85	15.53	72.23
	Population/habitat surveys (honorarium, vehicle, accommodation & tools – GPS & binocs)	18.43	3.00	0.00	0.00	24.64	46.06
	Surveys for land acquistion/rationalization, social aspects & other species status	0.00	5.40	5.94	5.94	0.00	17.28
	General field equipment (camera traps, laptops, cameras, accessories & stationary)	17.70	2.07	2.28	2.28	2.38	26.70
	Accommodation & travel	7.92	7.92	8.53	8.72	9.14	42.23
	Research/conservation laboratory (genetics & pesticides): equipment (part cost) & analysis charges	58.35	13.35	14.69	14.69	34.82	135.89
	Contingency (collaborative service charges & miscellaneous)	10.46	7.87	6.42	6.37	8.55	39.66
	Total costs of applied research	159.70	105.20	68.75	67.69	110.58	511.92
Capacity-building & awareness	Training of Forest/Conservation Staff (wildlife specialization & other trainings)	0.00	20.00	21.00	21.00	23.00	85.00
	Technology aided patrolling (developing tools, conducting training workshops for implementation & equipments)	13.14	17.14	13.35	4.40	4.60	52.63
	Workshops to sensitize non-forest officers (materials, travel & accommodation) – 3 workshops/yr & 15 participants/workshop	8.94	8.94	9.83	9.83	10.28	47.83
	Mobile workshops to sensitize local people (equipment, materials, travel & logistics) – 15 villages/yr & ~500 people/yr	4.00	3.60	3.96	3.96	4.14	19.66
	Awareness materials (posters, boards & documentary film)	0.40	7.40	8.14	2.20	0.00	18.14
	Contingency (collaborative services & miscellaneous)	6.32	7.85	8.31	7.57	7.85	37.91
	Total costs of capacity-building & awareness	32.80	64.93	64.60	48.96	49.87	261.18
Pilot habitat management	Predator-proof-fencing in critical enclosures	108.00	144.00	0.00	0.00	0.00	252.00
	Predator population management (traps, drugs, darting guns & neutering costs)	43.00	24.00	24.00	4.00	0.00	95.00
	Marking power-lines with Bird Diverters	91.00	0.00	0.00	68.25	68.25	227.50
	Agro-environmental Incentives & food provisioning in enclosures	5.00	5.00	53.00	53.00	0.00	116.00
	Total costs of pilot implementation of habitat management	247.00	173.00	77.00	125.25	68.25	690.50
	TOTAL	995.08	773.44	592.66	512.45	511.57	3385.20

CBC = Conservation Breeding Center

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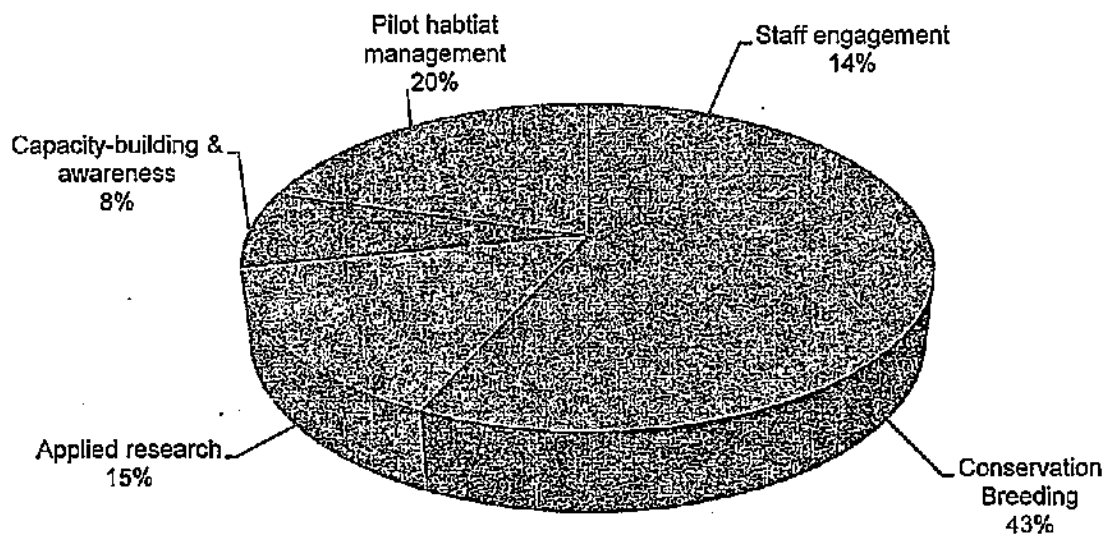
Summary table (Amount in Lakhs INR)

Head	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Staff engagement	79.28	83.96	92.15	101.14	111.02	467.55
Conservation Breeding	476.29	346.34	290.16	169.41	171.85	1454.06
Applied research	159.70	105.20	68.75	67.69	110.58	511.92
Capacity-building & awareness	32.80	64.93	64.60	48.96	49.87	261.18
Pilot habitat management	247.00	173.00	77.00	125.25	68.25	690.50
Total	995.08	773.44	592.66	512.45	511.57	3385.20

Pie-chart showing budget-allocation for various project activities



** 32% of the budget (Rs. 1089 lakhs) has been allocated for establishing the Conservation Breeding Centers – main & satellite facilities. The estimated costs include: (a) construction of a predator-proof enclosures around 4.5 km^2 area that have been sanctioned for the centers (12 km perimeter) @ Rs. 1,200,000/km = Rs. 144 lakhs; (b) construction of buildings (office, staff quarters, store & egg/food/chick chambers) with furniture in 600 m^2 space @ Rs. 50,000/m^2 = Rs. 300 lakhs; (c) construction of pens (separate for juvenile, adult & quarantine birds) in 9000 m^2 area @ Rs. 2500/m^2 = Rs. 225 lakhs; (d) breeding facilities (infrastructure, equipment, electrical/electronic appliances etc.) at two centers @ Rs. 120 lakhs; (e) uninterrupted water, security, power facilities at two centers @ Rs. 120 lakhs; and (f) modification costs of enclosures, buildings, facilities & infrastructure to accommodate more birds & unforeseen situations @ Rs. 180 lakhs.