Assessment of status, distribution and threats to the population of threatened Sarus Crane *Antigone antigone* in Uttar Pradesh

Final Report

Sálim Ali Centre for Ornithology and Natural History
(A Centre of Excellence under the Ministry of Environment, Forest and Climate Change,Govt.of India)
Anaikatty, Coimbatore - 641 108, India

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Final Report

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The Sarus Crane *Antigone antigone*, a resident crane of India, is the tallest flying bird in the world. In South-East Asia, two subspecies of the Sarus Crane have been reported; the Indian Sarus Crane *Antigone antigone antigone* and Burmese Sarus *Antigone antigone sharpii*. The first country-wide survey (1989) of the Indian Sarus Crane estimated the population to be about 13,000 individuals. Gujarat and Uttar Pradesh have been the stronghold states of the Sarus Crane population. According to the Asian Waterfowl Census in the 1980s, most of the population of this species was recorded in the states of Uttar Pradesh and Gujarat. Surveys were conducted in 2010 and 2019 in Uttar Pradesh at potential Sarus Crane habitats such as ponds, rivers, canals and agricultural fields. As land-use and land-cover patterns are changing, a study on the status of the population and conservation of the Sarus Crane in these landscapes assumes significance. The current study was carried out from February 2018 to October 2019, to estimate the population of the Sarus Crane, and assess the impact of chemical pesticides on the species in Uttar Pradesh. Data generated on these two components are presented in this report under Part I and Part II.

Field surveys were conducted across the known distribution range of the Sarus Crane, and we also collected data on Sarus Crane occurrence from historical records, and through questionnaire surveys, secondary data from published sources. Observations on the food and feeding habits of the Sarus Crane were also made.

To estimate the density and abundance, and determine the distribution of the Sarus Crane population, we applied Distance Sampling (DS) method. Further, species distribution models were made using Maxent algorithm and Wallace package in the R environment. We surveyed 521 grids (each 10 km × 10 km) spread across all the 75 districts of Uttar Pradesh. The greatest numbers of observations of Sarus Crane were recorded in the districts of Etawah (27.6%) followed by Mainpuri (19.5%), Shahjahanpur (8.2%), Maharajganj (6.9%), and Auraiya (6.3%). We estimated the probability of detection function of the target species from the model using the hazard-rate key function, hat (P_a) = 0.415 ±

0.0105. The population of Sarus Crane in Uttar Pradesh was estimated at 15,193.25 ± 2,905.1 (mean±SE) individuals (Coefficient of Variation (CV) of 0.191, while Lower Confidence Interval (LCI) was 10465.87, Upper Confidence Interval (UCI) was 22055.96, (df = 340.23). The Sarus Crane density was 0.0608 ± 0.0116 (mean±SE) (CV = 0.1912, LCI = 0.0419, UCI = 0.0882, df = 340.23) birds per sq. km. Distribution of the Sarus Crane showed that the highest probability (p = 1 to 0.8) of occurrence was in Etawah followed by Mainpuri, Shahjahanpur, Auraiya, Aligarh, Shahjahanpur, and Hathras districts. Our study also highlighted the fact that the Tarai belt has a good population of Sarus Crane.

The food items consumed by the Sarus Crane were recorded opportunistically during the surveys. Although the Sarus Crane is regarded as an omnivore, the food items consumed by this bird varied from season to season according to the availability in a locality. Sarus Cranes were observed consuming both animal and vegetable matter. The vegetable matter included tubers, grains and shoots, and animal matter comprised insects, avian eggs, crustaceans, molluscs, fishes and frogs. A total of 64 plant species belonging to 23 families were recorded as food plants of Sarus Crane during the present study.

Background information on agricultural practices, land-use pattern, common pests and pesticides used were gathered using questionnaire survey among farmers, pesticide dealers and relevant government departments. Additional data were collected from district agricultural departments and public domain. While around 13 crops were cultivated during *kharif* season, paddy was the major crop among other crops such as peanut, pigeon pea and corn. During *rabi*, 12 crops were cultivated and among which wheat was the most dominant crop. Cultivation of sugarcane, the least preferred habitat of Sarus Crane, was the maximum in Maharajganj followed by Gorakhpur district. About 23 different pests were documented on nine major prominent crops in the study area. Around 109 chemical pesticides were being sold to farmers in the study area, and among which chlorpyrifos, an organophosphate was the most widely recommended and used pesticide for controlling around 12 major pests. Over the years the quantum of pesticides used in Uttar Pradesh has been on the rise.

Further taking the available information on the distribution of the Sarus Crane in Uttar Pradesh into consideration, it was decided to focus the study in four important districts of Uttar Pradesh, namely Etawah, Mainpuri in the western UP and Gorakhpur and Maharajganj in the eastern UP. Breeding performance, mortality, residue levels of pesticides in select biological and non-biological matrices were assessed following standard methods in the field and laboratory. Chromatographic techniques were used to screen and estimate residues of 67 pesticides. During study period, totally 173 breeding pairs were studied in the referred four districts in five different micro-habitats, namely bund across paddy field (28), amidst paddy field (20), *Khet-talavadi* (35), marshland (55) and pond (35). Even though more nests were found in agricultural land, the Ivelev's index showed Sarus to prefer wetland habitats more than agricultural fields to breed. Overall breeding success among the four districts was 48%; lesser than the success rate reported earlier. Predation and nest removal were found to be influencing the breeding outcome of the Sarus Crane in the districts studied.

Towards assessing the impact of pesticides on the breeding outcome, samples of eggs, four from each of the four districts, were collected. In addition to documenting the size of the eggs, Shape Index and Eggshell index were calculated. While the average Shape Index was 64.90, Shell Index was 17.97 g m^{-2}. Among the 67 pesticides analysed, DDE was most frequently detected followed by HCH and chlorpyrifos. It was observed that none of the pesticides showed any strong relation with either breeding success or eggshell thickness. Presence of chlorpyrifos residues in the eggs is a matter of concern since its metabolite is a proven reproductive toxicant.

During the study period, efforts were made to gather information on mortality of the Sarus Crane and collect carcases for toxicological investigation from the entire Uttar Pradesh. Totally 22 incidents of mortality involving 24 individuals were recorded from three districts during the study period. Out of which while 21 Sarus Cranes died due to electrocution (confirmed based on post-mortem findings and circumstantial evidences) three died due to suspected monocrotophos poisoning. Fourteen individuals were analysed for pesticide residues in various tissues. Among the pesticides analysed, HCH, DDE,

chlorpyrifos and endosulfan were detected frequently. Variation in the level of contamination was not significant among the pesticides and organs studied. While endosulfan was the least detected pesticide, HCH was detected more frequently in the tissues. The reported concentrations of pesticides in the tissues of the Sarus Crane in the present study do not seem to be harmful, but certainly are indicative of continued exposure. Although the mean concentration of chlorpyrifos in the tissues of dead birds were below the reported threshold levels, detection of varying levels of chlorpyrifos in the vital organs including brain gives us a clear hint that birds could lose orientation leading to collision with power lines and eventual electrocution. Totally 180 food samples comprising rice paddy, wheat, fish and insects were collected from all the four districts. Among the 68 pesticides analysed, 17 pesticides, namely β-HCH, monocrotophos, quinalphos, acetamiprid, sulfosulfuron, acephate, atrazine, triazophos, chlorpyrifos, carbofuran, carbendazim, pretilachlor, cypermethrin, cyhalothrin, phorate, imidacloprid and profenofos were detected at varying levels. Chlorpyrifos was the most frequently detected pesticide while the concentration of cypermethrin in a sample from Gorakhpur district was the highest. Out of the 17 chemicals detected in the food materials of the Sarus Crane, levels of six chemicals, namely profenofos, quinalphos, monocrotophos, carbendazim, acetamiprid and β-HCH were above maximum residual limits permitted as per EU guidelines. Presence of phorate, monocrotophos and carbofuran in the food materials show that the Sarus Crane is exposed to chemicals which are proved to be toxic to birds. Contamination level in food did not vary significantly among the districts studied.

While 380 samples of soil/sediment were collected from nesting and congregation sites of the Sarus Crane from four districts, 95 pooled samples were analysed for residues of pesticides. Among the 67 pesticides analysed, 20 pesticides, namely chlorpyrifos, HCH, sulfosulfuron, DDT and its isomers, hexaconazole, imidacloprid, dieldrin, 2,4-D, carbendazim, pretilachlor, fipronil, endosulfan and its isomers, heptachlor, thiamethoxam, carbofuran and endrin were detected. Concentration of chlorpyrifos significantly varied among the four districts studied. Etawah had the highest number of pesticides detected (16) followed by Maharajganj (12), Gorakhpur (6) and Mainpuri (4). Detection of

residues of banned pesticides, namely β-HCH, endosulfan, heptachlor, endrin and dieldrin suggests that there should be regular and more stringent monitoring of chemicals that are sold from authorised private shops. Detection of chemicals such as carbendazim, carbofuran, fipronil indicates that the pesticides that are being used currently have the potential to harm the food base of all insectivorous / omnivorous birds including the Sarus Crane. Of all the pesticides, presence of chlorpyrifos above the Maximum Residue Limit is a matter of serious concern.

Based on the current study, it is adequately clear that the Sarus Crane is exposed to an array of pesticides through its food and soil. A majority of the detected chemicals in food and soil belong to organophosphate group. Even though they were not detected in the tissues and eggs of Sarus Crane, they have the potential to harm the food base of the Sarus Crane or directly harm them by causing acute poisoning. Therefore, there is a need for a pragmatic approach towards containing the impact of pesticides on the Sarus Crane. Integrated Pest Management Programmes, Good Agricultural Practice and Organic Farming are the tools available to reduce the impact of chemicals on the Sarus Crane. Farmers have to be trained regularly and effectively to manage crop pests more scientifically. Additionally, electrocution was found to be yet another problem that needs to be addressed. Electrocution with distribution lines was more than the transmission lines. While a few suggestions including insulating the existing naked conductors or replacing them with armoured cables in vulnerable locations have been made to mitigate the problem, collaboration with State Electricity Board and power generation and distribution companies, more viable solutions to the problem have to be worked out. Further, it is recommended to put in place an organized monitoring mechanism to record poisoning and electrocution in the entire UP for effective intervention and eventual conservation of the Sarus Crane. A set of recommendations for the future monitoring of the Sarus Crane population in the state is also made.

Recommendations

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Recommendations

Long-term monitoring of Sarus Crane population in its entire distributional range in the state of Uttar Pradesh is recommended. The present study successfully demonstrated “grid-based sampling approach” using 'Distance Sampling' technique to estimate the density and overall population of the Sarus Cranes in the state. Hence, it is suggested that once in four years a similar survey with the same methodology be carried out, in the same sampling areas, to estimate the density and population of the Sarus Crane. This will enable us to estimate the population trend of the Sarus Crane, over a time scale. The said exercise may be coordinated by a national level scientific organization involving trained man-power.

In addition, it is suggested to estimate the population of the Sarus Cranes in its entire distributional range across the state using “total count” method, twice a year, one each in summer and winter. This may be coordinated by the Forest Department, involving local/national NGOs and volunteers. Based on the results obtained, site specific management interventions, as required, may be executed by the Forest Department for the conservation of the Sarus Crane.

It is understood that in Uttar Pradesh, more specifically in the four districts where we did intensive study during the last two years, the current format of intensive farming is bound to continue. Hence, it is obvious that use of agrochemicals will continue to increase so also the impact on birds, specifically on the Sarus Crane. Sarus being a flagship species, saving it will also save many species of birds which are dependent on agricultural landscape to meet many of their needs round the year.

Problems due to pesticides to the Sarus Crane could be grouped under four categories, namely i) Acute poisoning that kills the bird instantly, ii) Long-term impact in terms of affecting the breeding outcome and eventually the population, iii) Indirect effects, and iv) Combination of any of the above.

SAY NO TO PESTICIDES might be the most desirable, simple, undemanding and straightforward solution to protect birds including the Sarus Crane. In the

process of achieving the same, taking the farming community along is a big challenge. This is mainly because we cannot afford to compromise on the quantum of food produced for obvious reasons. Hence, it is advisable to adopt a pragmatic approach. In this direction it is suggested that area specific and crop specific Integrated Pest Management Programmes (IPM) have to be implemented. It is just a combination of use of biological, cultural and chemical practices to control insect pests. Here, use of chemicals is kept as a last resort. While there are recipes available with agricultural universities, area specific, season specific, crop specific, pest specific programs have be to developed and demonstrated to farmers. Moreover, this technique will show results only when farmers collectively practice.

Good Agricultural Practice is yet another tool that is available to reduce dependence on pesticides. It is nothing but use of right chemical at the right time at right quantity, adopting the right method of application. But this also has to be designed in line with IPM. This aspect requires a lot of efforts as it involves educating the farmers and also policing. Eventually, the policing should be social policing. Farmers have to be trained to understand as to when intervention is needed. By and large, farmers resort to applying pesticides even when plants can recover on their own. Hence, the farmers have to be skilled to understand the point of intervention.

Based on the information gathered during the project period on the use of pesticides and also taking the toxicity of pesticides used in the study area into consideration, it is understood that the following are the major problem pesticides; phorate, carbofuran, monocrotophos, and chlorpyrifos. Additional research is needed in collaboration with agricultural universities to advise farmers as to when they should avoid which of these pesticides and where.

During the study period, we did not record any mortality of the Sarus Crane due to direct pesticide poisoning although there were strong evidences to suggest. Nevertheless, pesticides could indirectly harm Sarus by means of reducing its food base. Birds have the tendency to even skip breeding if they do not perceive food security to raise their chicks. As we have recorded residues of

17 pesticides in soil and 20 pesticides in food of the Sarus Crane, it is adequately clear that Sarus Crane's food is contaminated. Although, the tissues of the Sarus Crane did not have residues of new generation pesticides, they are very much prone to the impact in many indirect ways including inadequate food availability. Additional research is needed to understand the pesticides that affect the food base of the Sarus Crane in Uttar Pradesh.

The study revealed that the residues of legendary chemicals, such as DDT, dieldrin are on the decline in both biological and non-biological matrices. But, residues of new generation pesticides are found in the soil and food that is available to the Sarus Crane as referred above. This is a matter of concern and warrants action on priority basis.

By and large Sarus is not considered as pest on crops barring some locations in UP. Farmers in Maharajganj and Gorakhpur districts were with different psychology unlike Mainpuri and Etawah where farmers ignored damage, and did not retaliate. Nevertheless, safe chemical deterrents can be tried to protect germinating seeds from Sarus. It may be noted that Anthraquinone, a polycyclic aromatic hydrocarbon derived from anthracene was found to deter the Sandhill Crane in the US. But its efficacy and impact have to be tested in Indian condition before it is recommended.

Although deliberate poisoning of the Sarus Crane was not reported in UP, farmers resorted to chasing them and also removing their nests. In this regard farmers have to be trained to handle crop damage effectively rather than chasing or harassing Sarus. Moreover, Goverment also has to have a compensation plan.

In this context it is to be noted that the efforts taken by WTI has shown positive results in select districts in eastern UP.

Regarding sale of pesticides, Government has to regulate the sale and enforce strict regulations as per the guidelines in vogue. Only qualified persons should be issued license to sell chemical pesticides under proper framework of

guidelines. Unfortunately, unqualified shopkeepers incorrectly advise farmers in choosing a chemical. Our questionnaire survey revealed such less-known facts.

Chemical manufacturers should be made accountable, if their claims on safety of pesticides do not work. Companies should work closely with farmers to avoid the impact of chemical pesticides on birds and other non-target organisms. This could also be treated as Corporate Social Responsibility.

Farmers have to be trained regularly and effectively to manage crop pests more scientifically. There could be resource centers in every taluk headquarters for this purpose. Awareness on the toxicity of pesticides to birds and to farmers themselves is to be enhanced. During our two-year field work hardly we came across any farmer using proper protective gear while applying pesticides.

Electrocution and collision with powerlines have been the major reasons across the world for mortality of many species of birds, particularly birds which have large wing span. In this context the Sarus Crane has been one of the victims and there have been several reports in its distribution range, and more so in UP. During the study period while we recorded 24 incidents of mortality of Sarus Crane in UP, 19 cases were due to electrocution and two due to collision. Based on the information gathered, almost all the birds died while in flight. Moreover, electrocution with distribution lines was more than the transmission lines. This is mainly because transmission lines travel at greater height than distribution lines. In terms of solutions for the problem of collision and electrocution, they could be temporary and permanent. Although suggesting mitigation measures will fall outside our expertise, efforts were made to search for viable measures that might be applicable to the prevailing conditions in UP. A wide range of power line markings, such as bird flight diverter, bird flight flapper, fire-fly diverter, swinging plates, coloured aviation balls and spiral vibration dampers are practiced elsewhere in the world to warn birds so that they could change their flight path (fig A) (Fengshan Li et al., 2011).

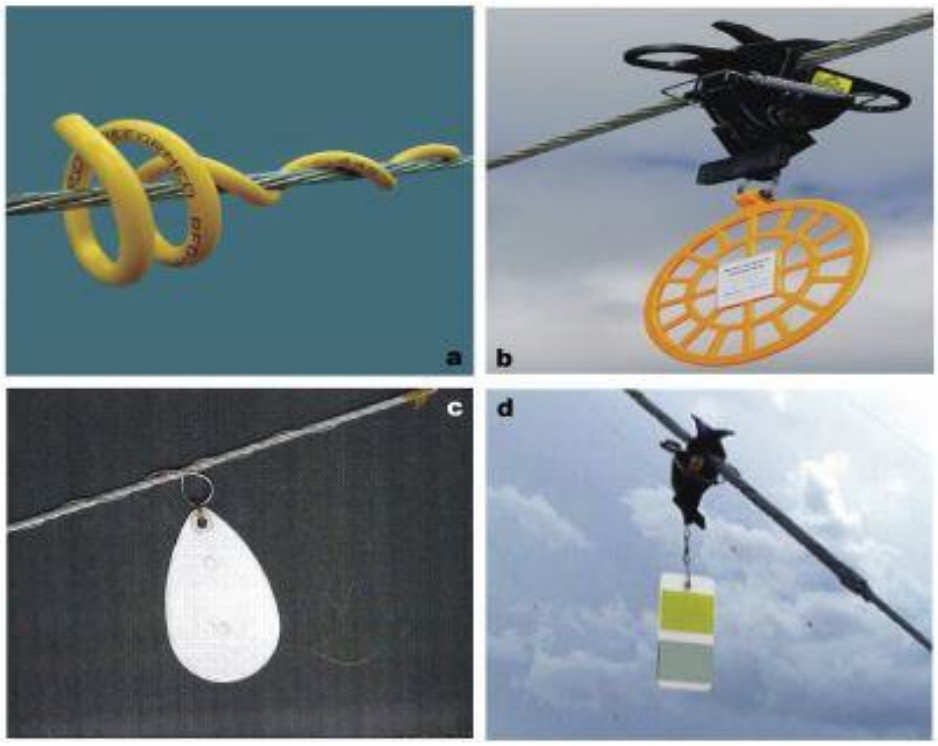

Fig. A: Examples of power line marking devices; bird flight diverter (a & b), bird flapper (c), fire fly diverter (d) (Fengshan Li et al., 2011).

While these are temporary solutions, they may be worth experimenting. Permanent solution will be to shift the power lines away from the Sarus Crane breeding and nesting/ roosting areas. While this may be possible in protected wetlands, in agricultural landscape, it may be impracticable. Hence, in areas where possibilities of electrocution are more, we recommend insulating the existing naked conductors or replacing them with armoured cables. One of the success stories is at Kokkare Bellur Community Reserve, Karnataka. Nesting population of Spot-billed Pelicans faced threat due to distribution lines that crisscrossed the village so also the breeding colonies. Subsequent to installing armoured cables, the Pelicans and other bigger birds such as Painted Stork are safe (fig B). It may be noted that during the referred study period in Aimanpur village, Mainpuri district, we recorded five incidents of electrocution that involved the Sarus Crane. While this location may be a fit case for installing armoured cables, further monitoring is needed to check additional vulnerable areas.

Further, the entire network of transmission and distribution lines in the Sarus Crane areas have to be mapped, particularly in the agricultural and wetland landscapes to locate the stretches which are more prone to electrocution and collision. In collaboration with State Electricity Board and Power generation and distribution companies, more viable solutions to the problem have to be worked out. It is highly recommended that no new power lines should be permitted to pass through important bird areas so that many species of larger birds such as raptors and Sarus Crane could be saved.

Fig. B: Use of armoured cable in Kokkare Bellur village, Karnataka

It is recommended to put in place a monitoring mechanism to record mortality of Sarus Crane due to poisoning, electrocution, and other causes of Sarus Crane death in the whole state, more specifically in areas which are considered as strong-holds of the Sarus Crane.

Further, it is recommended to have a proper treatment and first aid protocol in place to attend to poisoned or injured Sarus, which veterinarian could access.

In brief, organized monitoring, and additional research taking the existing conservation issues of the Sarus Crane and farmers' grievances into account are the needs of the hour to conserve the Sarus Crane in Uttar Pradesh.

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