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

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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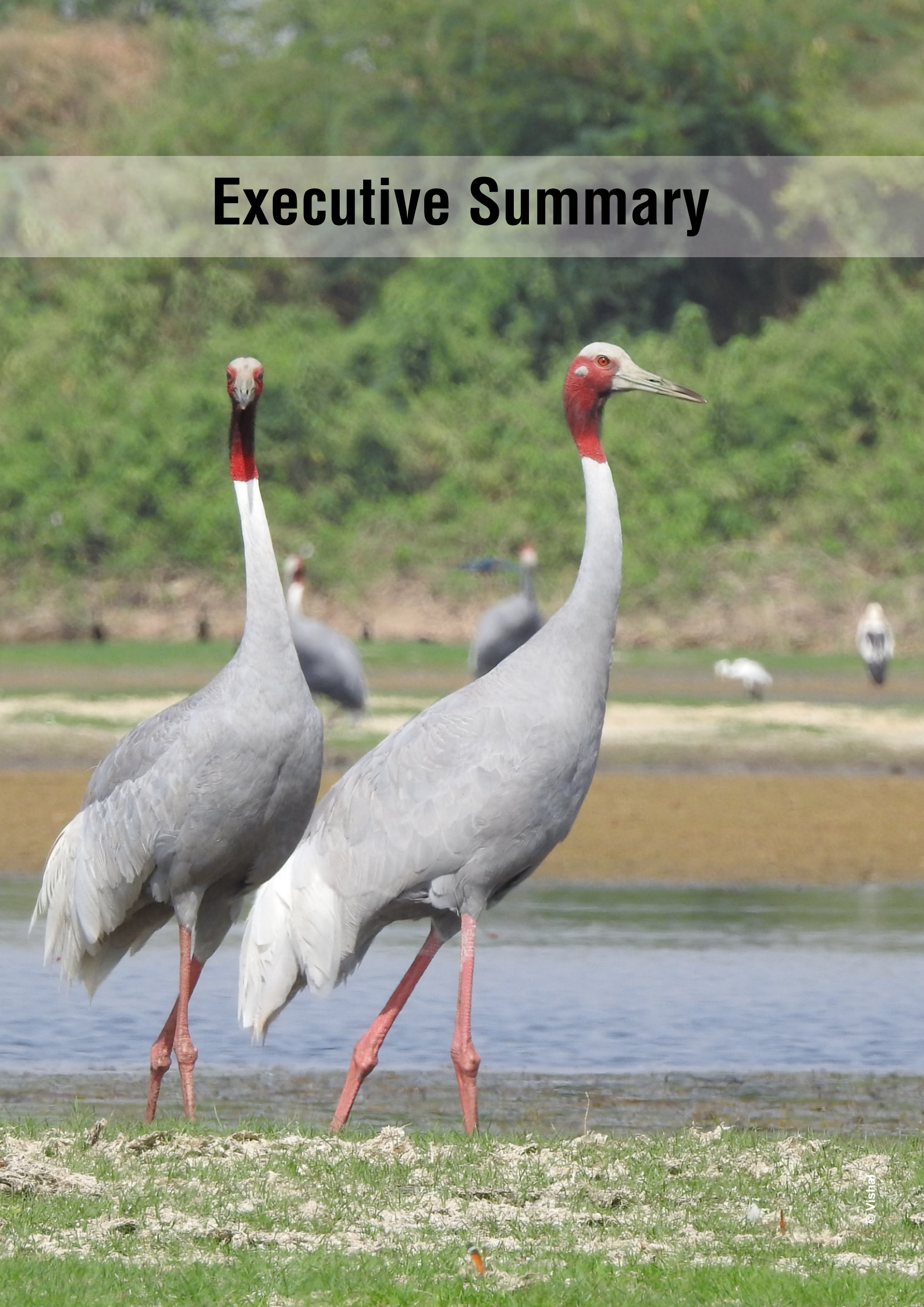

Executive Summary

Gujarat and Uttar Pradesh have been the stronghold states of the Sarus Crane *Antigone antigone* population in India. As land-use and land-cover patterns are changing over the last three decades, a study on the status of population and conservation of the Sarus Crane in these landscapes assumes significance. The study was carried out from February 2018 to October 2019 to assess the present status of the Sarus Crane population and quantitatively assess the ill effects of contaminants, specifically pesticides on the Sarus Crane in the state of Gujarat. Observations on the food and feeding habits of Sarus Crane were also made during the study. To estimate the density and abundance, and determine the distribution of the Sarus Crane population, we used Distance Sampling (DS) method. Further, species distribution models were made using Maxent algorithm and the Wallace package in the R environment.

We surveyed 322 grids, (size of 10 km × 10 km), spread across all the districts of Gujarat. The highest numbers of observations of Sarus Crane were recorded in the districts of Ahmedabad (39 %) followed by Anand (36 %), and Kheda (11%). We estimated the probability of detection function of the target species from the top model using half-normal key function, hat (P_a) = 0.932 ± 0.067 (mean±SE). The population of Sarus Crane in Gujarat was estimated at 1788.72 ± 378.44 (mean±SE) individuals with a coefficient of variation (CV) of 0.212, while lower confidence interval (LCI) was 1185.39 upper confidence interval (UCI) was 2699.11, (df = 387.82). The estimated population of Sarus Crane during the present study is comparable with the previous study in the state during 2000. The Sarus Crane density was estimated to be 0.00894 ± 0.0019 (mean±SE) (CV = 0.211, LCI = 0.00593, UCI = 0.0135, df = 387.82) birds per sq. km. The distribution of the Sarus Crane showed that the highest probability (p =1 to 0.8) of its occurrence was in the districts of Ahmedabad, Anand, Surendarnagar, Kheda and Vadodara. Our study highlighted that Dahod and Surat also have a good population of Sarus Crane.

Food items consumed by the Sarus Crane were recorded opportunistically during the Sarus Crane counts. 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, shoots, and the animal matter comprised insects, avian eggs, crustaceans, molluscs, fishes and frogs. A total of 22 plant species belonging to eight families were recorded as food plants of Sarus Crane during the present study.

Taking advantage of available information on the distribution of Sarus Crane in Gujarat, it was decided to focus the toxicological study in three important districts of the state, namely Kheda, Anand and Ahmedabad. Major aspects studied were the following; Breeding performance of Sarus Crane and its relation with pesticide residues in eggs; causalities of Sarus Crane; pesticide residues in tissues of Sarus Crane, soil/sediment and food materials to assess the potential impact of pesticides; and existing cropping pattern, pests and pesticides used in the referred districts through a questionnaire survey. Additional data were collected from District Agricultural Departments and public domain. While rice paddy was predominantly cultivated during *kharif* and *zaid* seasons, wheat was the main crop during *rabi*. About 32 major pests were documented to be affecting the crops grown in the state while 66 chemicals were sold in the open market to protect the crops.

During the present study, totally 68 breeding pairs of Sarus Crane were monitored in the referred three districts. Nest diametrics in different microhabitats were measured. Parameters such as the nest length, nest height and water depth varied significantly among the microhabitats. While 44 nests were located in agricultural habitat, wetland habitat had 24 nests. Sarus Cranes were found to prefer the wetlands over agricultural land for breeding. This was also substantiated by Ivelev Selectivity Index. While the overall breeding success among the three districts was 43%, the hatchling and fledgling success were 66.08 % and 68.42 % respectively. Predation and anthropogenic activities such as relocation of eggs and nests by farmers 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 of Sarus Crane, six eggs were collected from two districts, namely Kheda and Anand. The morphometric measurements of the eggs were recorded, and it was observed that the eggs were marginally different in terms of their weight, width and length from the previous records in Gujarat while the eggshell thickness was measured for the first time. In addition to documenting size of the eggs, Shape Index and Eggshell Index were calculated. While the average Shape Index was 61.2, Shell Index was 17.65 g m^{-2}. Of all the pesticides analysed, chlorpyrifos was most frequently detected followed by DDE. It was observed that chlorpyrifos showed strong relation with eggshell thickness. However, due to lack of published information on the role of chlorpyrifos in eggshell thinning, we are unable to make any interpretation. Nevertheless, presence of chlorpyrifos residues in the eggs is a matter of concern since its metabolite is a proven reproductive toxicant.

Twenty causalities of Sarus Crane were recorded from different parts of Gujarat during the study period. Out of which, 18 Sarus Cranes were confirmed to have died. While one bird survived, fate of the other one was unknown. Electrocution, based on post-mortem findings and circumstantial evidences, was confirmed to be the cause of death in 12 Sarus Cranes. While four Sarus died due to kite string injuries, one died due to trauma. Gout, a rare occurrence was the reason for the death of one juvenile Sarus Crane. Tissues of seven birds could be collected from three districts for toxicological investigations. Among the pesticides analysed, chlorpyrifos, HCH, DDT, endosulfan and heptachlor were detected frequently. Variations in the level of contamination were not significant among the pesticides and organs studied. While endosulfan and heptachlor were the least detected pesticides, chlorpyrifos 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 detrimental, but certainly are indicative of continued exposure. Poisoning of Graylag Geese,

Northern Pintail and Purple Swamphen due to carbofuran was confirmed in wetlands which are also utilised by the Sarus Crane. Hence, it is quite likely that Sarus too could be victim to such careless activity of people living nearby.

Totally 179 food samples comprising rice paddy, wheat, fish and insects were collected from all the three districts, and 42 pooled samples were analysed for pesticide residues. Among the 67 pesticides analysed, 12 pesticides, namely β-HCH, chlorpyrifos, carbofuran, DDE, tansfluthrin, thiamethoxam, ethion, tricyclosole, carbendazim, phorate, imidacloprid and profenofos were detected at varying levels. Chlorpyrifos was the most frequently detected pesticide followed by thimethoxam. Level of carbofuran above MRL value, recorded in food materials is a matter of concern. While 104 samples of soil/sediment were collected from nesting and congregation sites of the Sarus Crane from three districts, 60 pooled samples were analysed for residues of pesticides. Among the 67 pesticides analysed, 23 pesticides, namely HCH, DDT, chlorpyrifos, pretilachlor, heptachlor, transfluthrin, dieldrin, cyhalothrin, flubendiamide, thiamethoxam, triazophos, 2,4-D, tricyclazole, imidacloprid, butachlor, ethion, quinalphos, hexaconazole, carbendazim, pendimethalin, phorate, fluchloralin and carbofuran were detected at varying levels. Out of 23 pesticides, HCH and chlorpyrifos were above the MRL levels. Residues of HCH above alarm levels in the soils from nesting and congregation sites of the Sarus Crane were also reflected in the tissues and eggs of the Sarus Crane collected from the same locations. The present level of HCH contamination appears to be a matter of concern, and it has to be monitored in the environment until the levels reduced to below guideline values.

The present study also documented poaching of waterfowl through poisoning in some of the wetlands, especially in Kheda district which is one of the strong hold areas of the Sarus Crane population. Although poachers may not particularly target the Sarus Crane, unintentionally they may end up killing Sarus too as these birds share the same habitat with waterfowl. The frequency of occurrence of chlorpyrifos was the highest among all the components analysed, except soil where chlorpyrifos was the second highest after HCH. Although the concentration of chlorpyrifos in all the samples analysed is not alarming, it is a matter of concern, because it is extensively used in rice paddy, and it has the potential to affect the food base of the Sarus Crane more so during the breeding period.

Towards protecting the Sarus Crane, it is suggested that area specific and crop specific Integrated Pest Management Programmes (IPM) could be put into practice. Farmers have to be trained regularly and effectively to manage crop pests more scientifically. Good Agricultural Practice is yet another tool that is available to lessen reliance on pesticides while Organic Farming might be the eventual need. Since, many Sarus Cranes have died due to electrocution, suggestions including insulating exposed conductors and installing armoured cables are made to mitigate the problem, and save the Sarus Crane in Gujarat. Suggestion has been made to put in place a monitoring mechanism to record poisoning and electrocution of the Sarus Crane. Further the need for a treatment protocol to be followed to attend to any casualty in Sarus Crane is also indicated. A set of recommendations for future monitoring of the Sarus Crane population in the state is also made. This report has two parts, while Part-I deals with ecological aspects, Part-II deals with toxicological investigations.

Recommendations

Recommendations

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

In addition, it is suggested to estimate the population of Sarus Crane 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 Sarus Crane.

Based on the information gathered for this project in Gujarat, it is adequately clear that problems due to pesticides exist at varying magnitudes in the state. Further, while the demand for food is bound to increase in the years to come, the available land for cultivation is sure to decrease. Hence, the dependence on agrochemicals is unlikely to diminish. Managing the ill effects of chemical contaminants on ecosystem components, more specifically on birds associated with agroecosystem will continue to be a challenge. In this context a set of recommendations are drawn up so as to minimize the impact on birds, including the Sarus Crane.

The impact due to pesticides on birds could be acute poisoning that kills the bird instantly, long-term impact in terms of affecting the breeding outcome and eventually the population, indirect effects that include diminishing food base and combination of any of the above.

While advising farmers to completely stop using chemicals might be the easiest recommendation, putting that into practice may be not possible at once. It is presumed that a slow, but sustainable approach might be acceptable to farmers.

In this direction it is suggested that area specific and crop specific Integrated Pest Management Programmes (IPM) could be put into practice. It is just a combination of use of biological, cultural and chemical practices to control the pests. Here, use of chemicals is kept as a last resort to act on a pest. While there are protocols available with agricultural universities, area specific, season specific, crop specific, pest specific IPM, have to be developed in collaboration with agricultural scientists, and the same has to be demonstrated to farmers. Incidentally, this programme will work the best, if farmers join together, and work towards mobilizing the necessary inputs. Hence, this technique will show tangible results only when farmers collectively practice.

Good Agricultural Practice is yet another tool that is available to lessen reliance on pesticides. It is nothing but employing an appropriate chemical at the right time, at right quantity, adopting the right method of application. But this also has to be designed similar to IPM. This aspect requires a lot of efforts as it involves educating the farmers and also policing them. Eventually, policing should be social- policing. Farmers have to be trained to understand as to when interventions are needed.

Based on the data gathered during the project period on the use of pesticides and also taking the toxicity of pesticides used in the three districts into consideration, it is learnt that pesticides, namely phorate, carbofuran, monocrotophos, chlorpyrifos are the major problem pesticides. Specific research may be needed in partnership with agricultural universities to handle each of the common pests without or with a little pesticide.

During the study period, we did not record any mortality of Sarus Crane due to direct pesticide poisoning although there were circumstantial evidences to suggest in a few places. Moreover, pesticides could indirectly harm Sarus by means of reducing its food base. It is a fact that birds have the tendency to even

skip breeding, if they do not perceive food security to raise their chicks. Further, detection of residues of 23 pesticides in soil and 12 pesticides in food materials of the Sarus Crane has adequately confirmed that the Sarus Crane's food is contaminated. Although, the tissues of 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 Gujarat, more specifically in districts where we have good population of Sarus, and also extensive cultivation is practiced.

Sarus, being a predominant seed eating bird, has the possibility of ingesting pesticides when they feed on treated seeds. Hence, efficient seed deterrent can be tested out. Such practice seems to have yielded result while handling the Sandhill Crane in the US. But the efficacy of any such chemical has to be tested in specific areas taking the seed and soil type into consideration in collaboration with agricultural scientists.

Although intentional poisoning of the Sarus Crane was not observed in Gujarat during the study period, farmers resorted to chasing them and also removing their nests in some locations to avoid crop damage. In this regard farmers have to be trained to handle crop damage effectively rather than chasing or harassing the Sarus. Moreover, Government also has to have a compensation plan. In this context, it is worth mentioning that the efforts taken by Dr. Jatinder Kaur of United Phosphorus Limited (UPL) have shown encouraging outcome in select locations in Gujarat.

Regarding sale of pesticides in the state, it has to be more organized so as to prevent sale of spurious chemicals to farmers. Only qualified persons should be issued license to sell chemical pesticides under proper framework of guidelines. Unfortunately, people with good business acumen run the business and incorrectly advice farmers in choosing a chemical. Nevertheless, our study reveals that farmers in Gujarat are relatively well-informed.

Chemical manufacturing companies should be made responsible if their claims on safety of pesticides do not work. They should work closely with farmers to avoid the impact of chemical pesticides on birds and other non-target organisms. This should perhaps 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.

Electrocution and kite string injuries are the other major reasons for Sarus Crane causalities in Gujarat. Electrocution has been one of the major reasons across the world for mortality of many species of birds, particularly birds which have large wing span. In this context Sarus has been one of the victims, and there have been several reports in Gujarat. During the study period while we recorded 18 incidents of mortality of the Sarus Crane in Gujarat, 12 cases were due to electrocution. Based on the information gathered, almost all the birds died due to collision with electricity distribution lines while in flight. Solutions for the problem of collision and electrocution, could be temporary and permanent. Although suggesting mitigation measures might fall outside our expertise, efforts were made to search for viable measures that might be applicable to the prevailing conditions in Gujarat. 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 to warn birds so that they could change their flight path (Fig A) (Fengshan *et al.*, 2011).

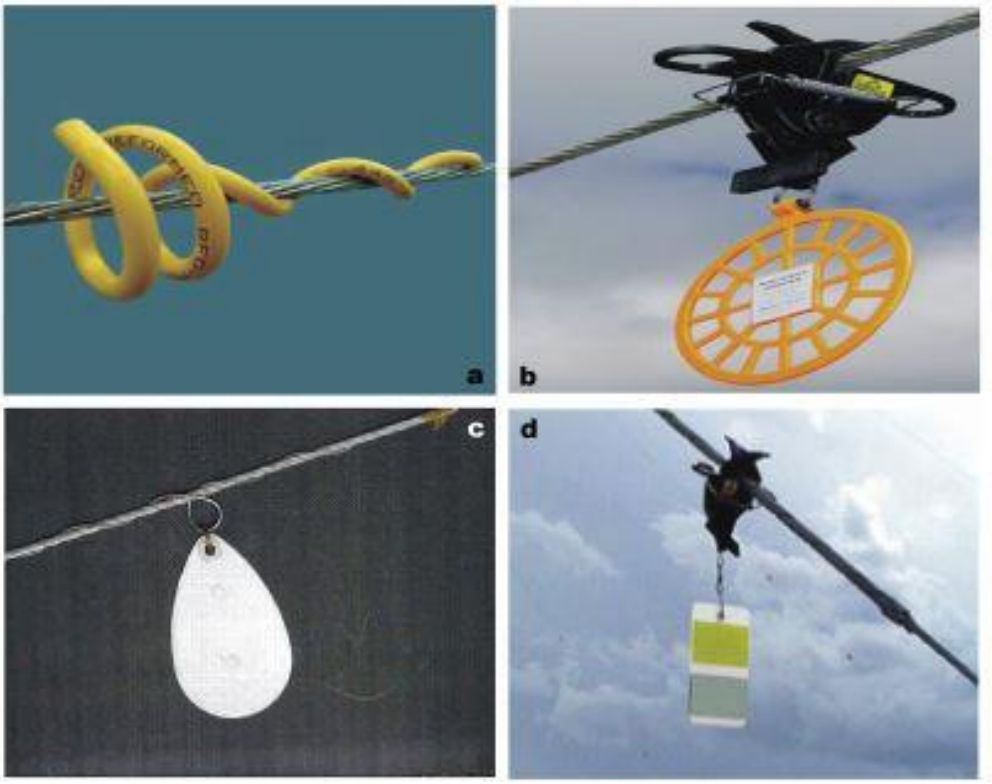

Figure A: Examples of power line marking devices. (a) & (b) bird flight diverter; (c) bird flapper; (d) fire fly diverter. (Fengshan *et al.*, 2011).

While these are temporary solutions, it might 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, 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 these days (Fig. B).

It may be noted that during the referred study we found villages, namely Vastana, Khandhali and Indervarna in Kheda district, Daloli, Padra and Bhanderaj in Anand district, Dholka, Sanand, Bavla and Sankol in Ahmedabad district to be fit cases for installing armoured cables. This may be implemented in phased manner.

Figure B: Use of armoured cable in Kokkare Bellur, Karnataka

Further, the entire network of transmission and distribution lines in Sarus Crane areas have to be mapped, particularly in the agricultural and wetland landscapes to locate the stretches which are more prone to electrocution. In collaboration with, Gujarat State Electricity Board and power generation and distribution companies, more viable solutions to the problems have to be worked out. It is highly recommended that all new power lines passing through important bird areas to be bird-friendly or rerouted so that many species of larger birds such as raptors and the Sarus Crane could be saved.

During Uttarayan when people fly kites, they end up injuring Sarus. Unfortunately, a few succumb to injuries every year. Due to the awareness programme conducted by Gujarat State Forest Department and NGOs, such incidents have come down over the years. Yet, it is a potential threat and has to be attended to.

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

It is also recommended to have a proper treatment and first aid protocol in place to attend to poisoned or electrocuted or injured Sarus Crane which veterinarian could access.

In brief, structured monitoring and additional research, taking the existing conservation issues of the Sarus Crane and farmers' grievances into account, are recommended to conserve the Sarus Crane in Gujarat.

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